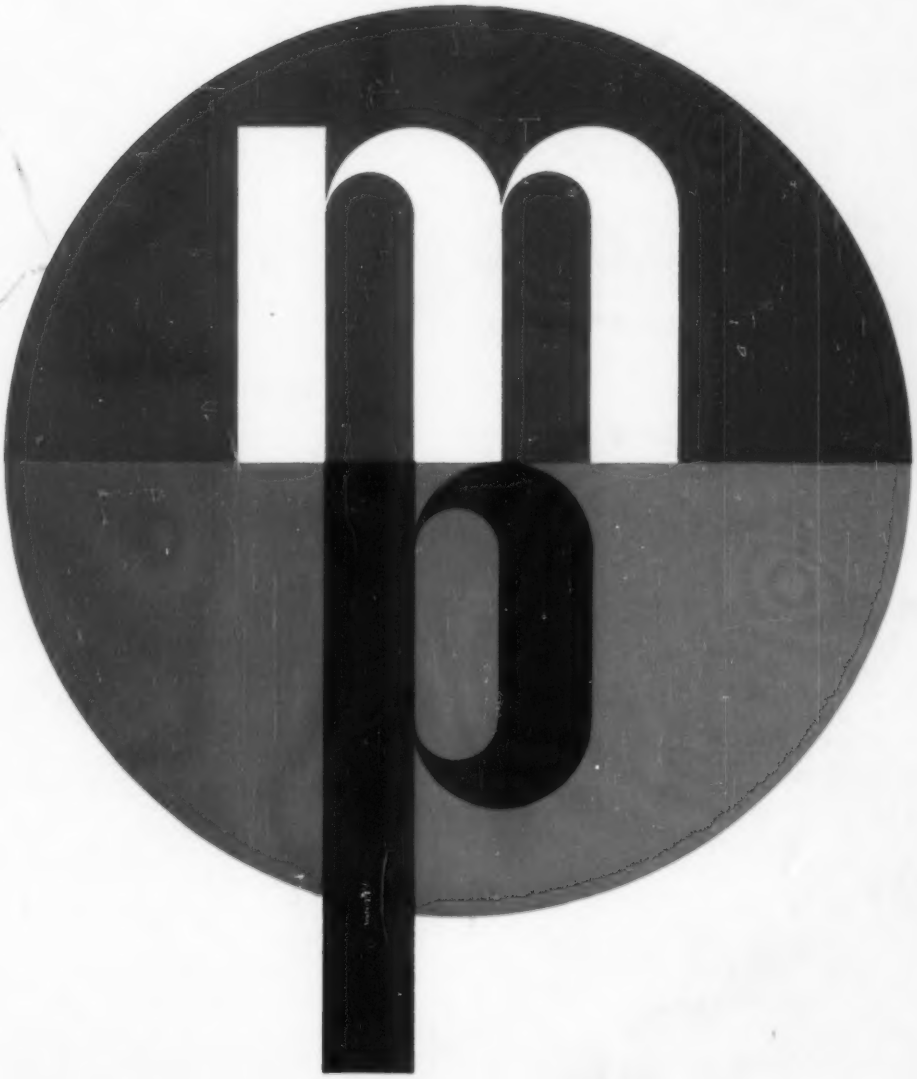
MODERN PLASTICS



February 1956

page 37 **The important news at a glance . . . in the new Plastiscope presentation**

page 81 **Revolution in reinforcements**

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MODERN PLASTICS*

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Modern Plastics Executive and Editorial Offices 575 Madison Avenue, New York 22, N.Y.

Modern Plastics published monthly by Breskin Publications, Inc., at Emmett St., Bristol, Conn. Modern Plastics Encyclopedia Issue published as second issue in September by Plastics Catalogue Corp., at Emmett St., Bristol, Conn. Second-class mail privileges authorized at Bristol, Conn. Subscription rates (including Modern Plastics Encyclopedia Issue, which is not sold separately), payable in U.S. currency: In United States, its possessions, and Canada, 1 year $6, 2 years $11, 3 years $15; Pan-American countries, 1 year $10, 2 years $17, 3 years $24; all other countries, 1 year $15, 2 years $25, 3 years $35. Single copies 75¢ each (Show issue, $1.00) in the U.S., its possessions, and Canada; all other countries $1.50 (Show issue $2.00). *Reg. U.S. Pat. Off.

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Editorial

Our new appearance

With this issue MODERN PLASTICS has a distinctive new look which we believe readers will find both stimulating and refreshing.

The old cover, the old types, the old headings, and the old format have been swept away and replaced by a distinctive new format which represents the best modern thinking in the fields of typography, layout, and the graphic arts.

Readers will find a refreshing new ease of reading in the larger type, the comfortably widened columns in the General Section, and the increased use of "breathing space" in the layouts. A new and exhilerating sense of visual excitement will result from the bold use of color and illustration, and the disciplined spacing of type.

The cover of MODERN PLASTICS has always been a "trademark," recognized throughout the world. We believe that the new cover design will be even more representative of the significance of this magazine and the industries it serves.

The new format is the creation of Bradbury Thompson, who can be called, without much argument, the No. 1 format designer of the United States. As art director of *Mademoiselle*, he produces each month one of the world's most beautifully styled magazines. As designer and typographer of such artists' inspiration pieces as the annual Graphic Arts Production Yearbook, Art News and Art News Annual, and Westvaco Inspirations, he has been called "the art director's art director." In 1950 some 1200 of the country's leading art directors, members of the National Society of Art Directors, named him "Art Director of the Year."

For his distinction in both editorial and advertising art, the New York Art Directors Club has showered him with Medals (1945, 1947, 1951, and 1955) and Awards (1946, 1953, 1954, and 1955). The American Institute of Graphic Arts has frequently included his work in its "Fifty Books of the Year" and its "Printing for Commerce" shows.

Something besides a new appearance begins with this issue: A change in the presentation of the Plastiscope. In addition to the regular section in the back of the book, comment on the most recent and important events affecting the plastics industry appears well up front, printed on colored stock.

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New York 22, N. Y.

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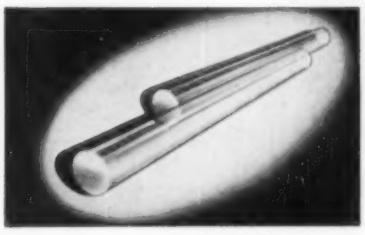

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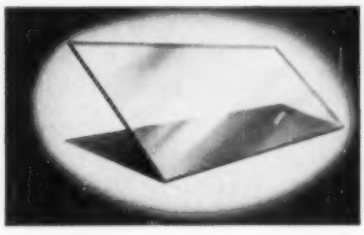

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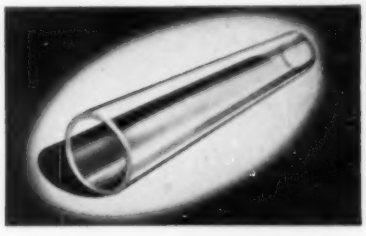

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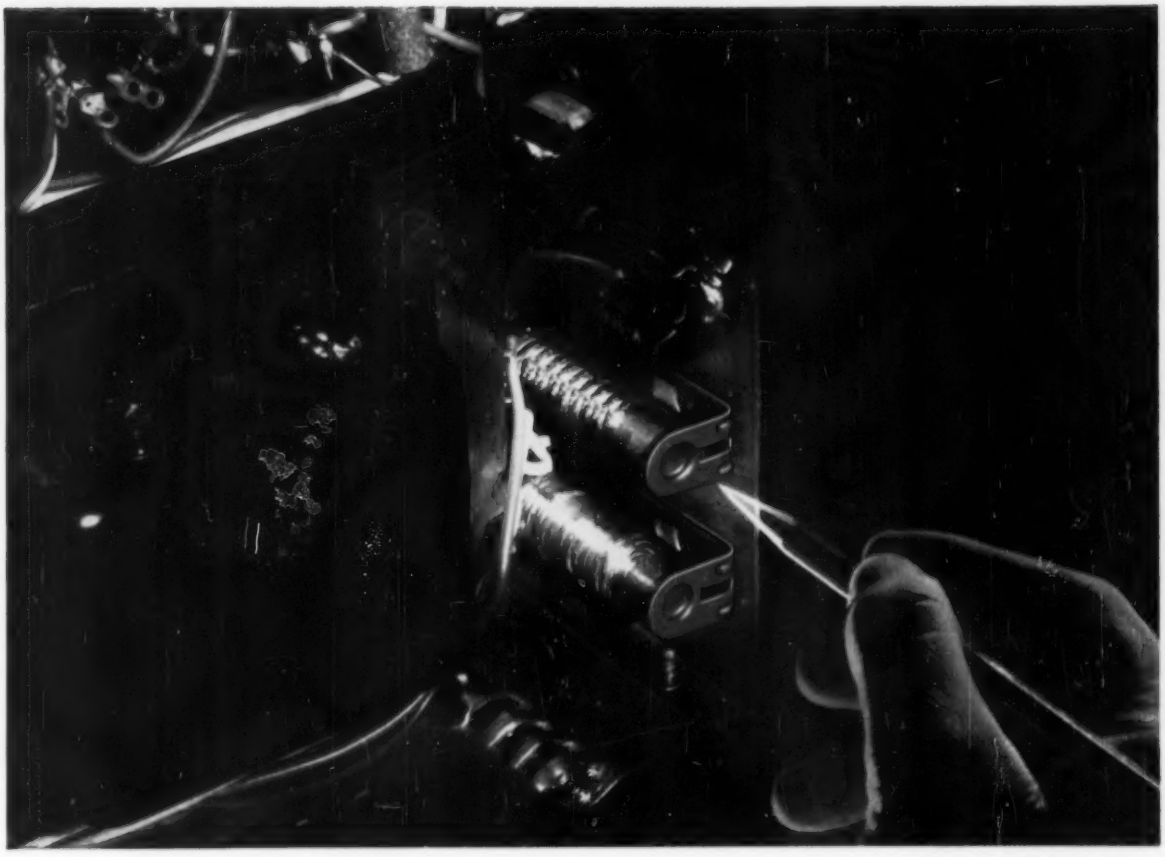

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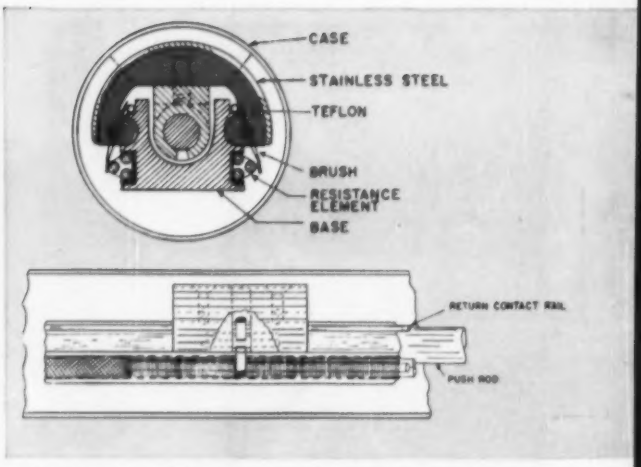
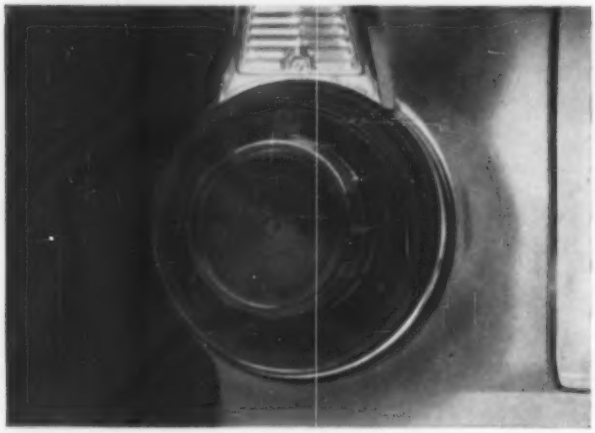


TEFLON is used in many electrical and electronic applications. Its outstanding heat resistance made this miniature potentiometer possible.



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LUCITE® acrylic resin is especially suited to decorative purposes. It is available clear or in a wide range of transparent, translucent and opaque colors. It has the needed combination of beauty and durability for automotive applications. The 1956 models feature "Lucite" for taillight lenses, dials and hood ornaments. "Lucite" has high impact strength, resists crazing and weather, and can be economically fabricated by several efficient techniques.

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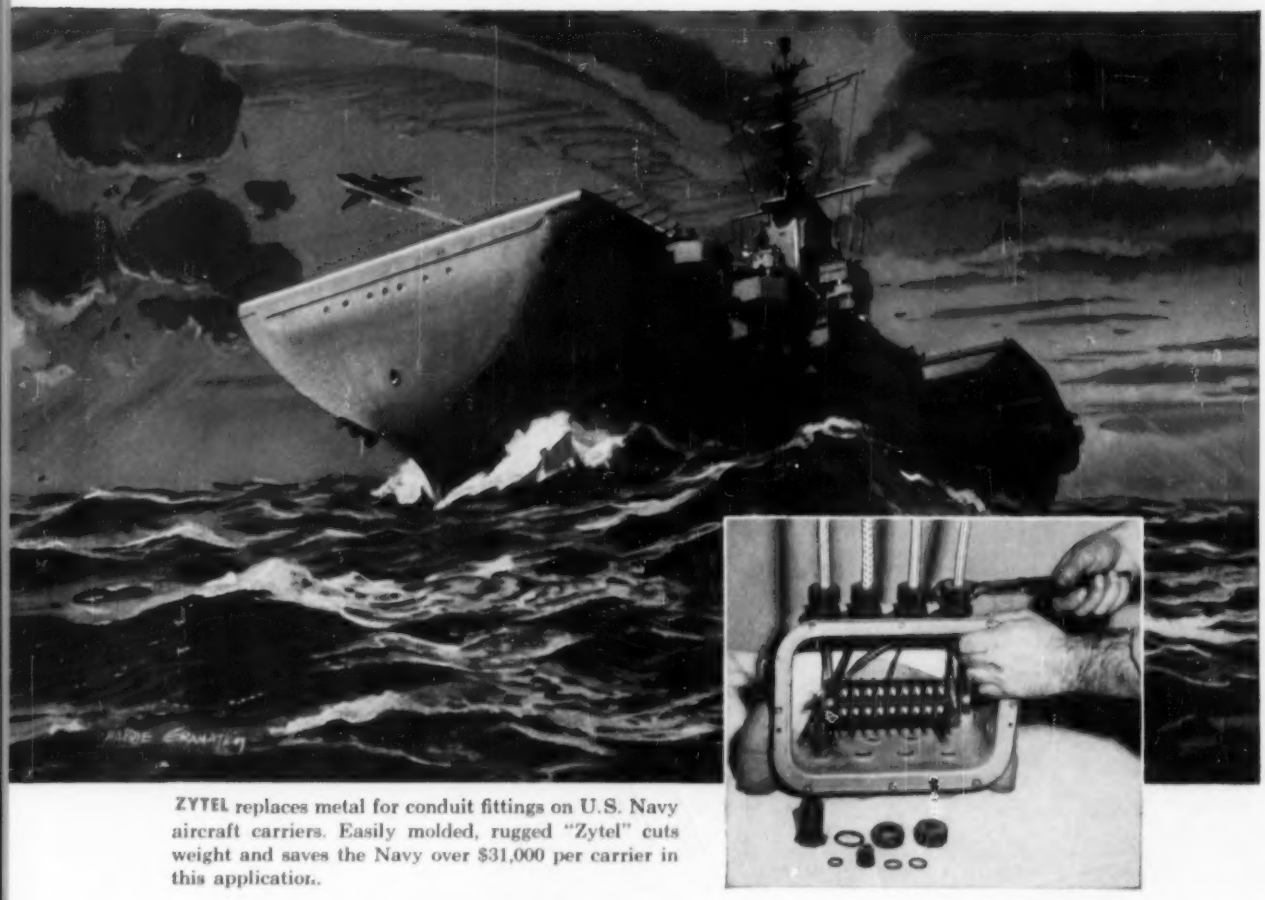

ZYTEL replaces metal for conduit fittings on U.S. Navy aircraft carriers. Easily molded, rugged "Zytel" cuts weight and saves the Navy over $31,000 per carrier in this application.

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this application since a sleeve must slide back and forth over the core. (Manufactured by the Pacific Scientific Co., Los Angeles, California.)

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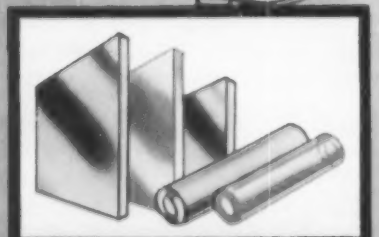

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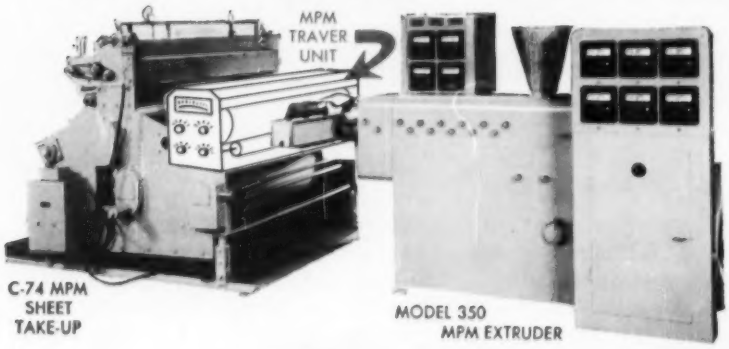

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PRODUCES POLYETHYLENE FILM READY FOR PRINTING AND FABRICATION

- Eliminates need for elaborate ventilating systems
- Up to 60% less voltage
- Speedier production on all types of polyethylene formulations including the new "SLIP" compounds
- Results of treatment for printability are now both predictable and uniform
- Operates electronically without open flame, dangerous heat or cooling problems
- Electronic MPM-Traver unit is simple to operate and gives polyethylene film a surface that is readily printable

MPM-Traver units are available separately

Features of MPM C-74 TAKE-UP

- Speed control from zero to 170 F.P.M.
- Adjustable Tensioning
- Automatic trimming of film and windup of trim for complete salvage of waste
- Alignment of film always certain
- Incorporates all the latest improvements

MPM C-74 take-up available as a separate unit

MAKE YOUR OWN SCOTCH TAPE TEST . . . send for samples of polyethylene that has been treated by the MPM-Traver unit.

MPM BUILDS 100% COMPLETE "PACKAGED UNITS"

In many cases we deliver *complete plants* that include dies and every piece of equipment required to produce the customer's product. These MPM "Packaged Units" extrude, cool, cut, treat for printability, pull off, trim and reel . . . all in one continuous operation.

mpm

modern plastic machinery corp.

Manufacturers and Designers of

THE MOST ADVANCED PLASTIC PROCESSING EQUIPMENT

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IN USE IN THE UNITED STATES AND THROUGHOUT THE WORLD

West Coast Representative: 8510 Warner Drive, Culver City, Calif.

Answer to an absorbing

In manufacturing dry blending vinyl resins, the primary problem is to produce a resin which will accept plasticizer at a rapid, yet uniform rate. The resin also must give a sandy or free-flowing mix, must process easily on any type of forming equipment and must do so at no sacrifice of physical properties.

In developing a resin to meet these requirements, Goodyear vinyl specialists first made a microscopic examination of resin particles at various stages of dry blending. From this they found that the plasticizer first is quickly adsorbed as a thin layer on the surface of the particle. Then as heat is transferred to the particle, this layer moves inside or is absorbed.

This study also revealed the importance of particle size, shape and structure to proper plasticization and indicated the nature of the particle needed. With this background, the researchers set out to tailor-make a series of dry blending resins.

Pictured at right is one result of their efforts – particles of a typical PLIOVIC DB (dry blending) resin under magnification. Note how well these particles of PLIOVIC answer the requirements for porosity and uniformity. Note also how thoroughly they are plasticized as indicated by their high degree of translucency.

In addition to their excellent plasticizing properties, the PLIOVIC DB resins are readily calendered, extruded or molded, exhibit maximum physical properties, permit you to take safe advantage of the speed and low cost of dry blending. Write for details, samples and the latest *Tech Book Bulletin* to:

Goodyear, Chemical Division, Akron 16, Ohio

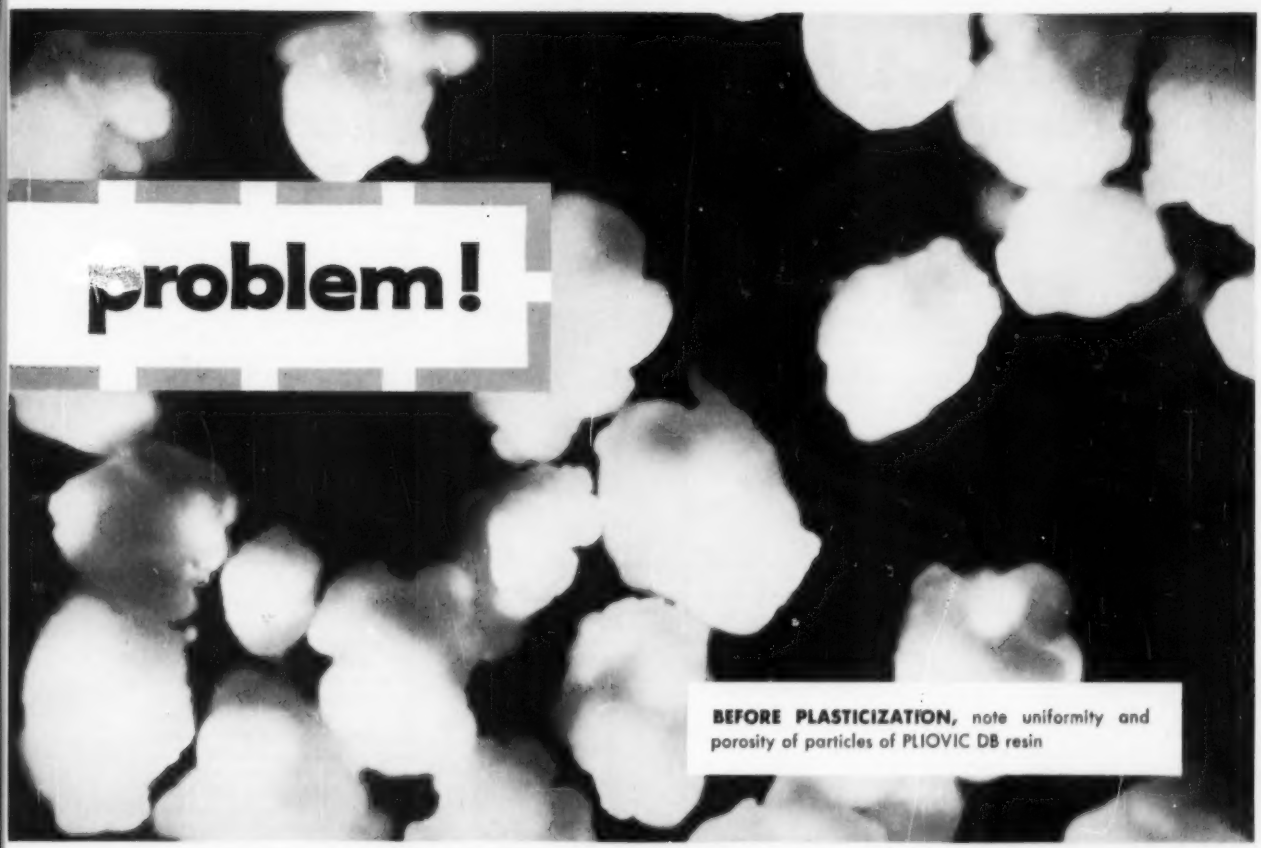
Chemigum, Plioflex, Pliolite, Plio-Tuf, Pliovic – T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

CHEMICAL
GOODYEAR
DIVISION

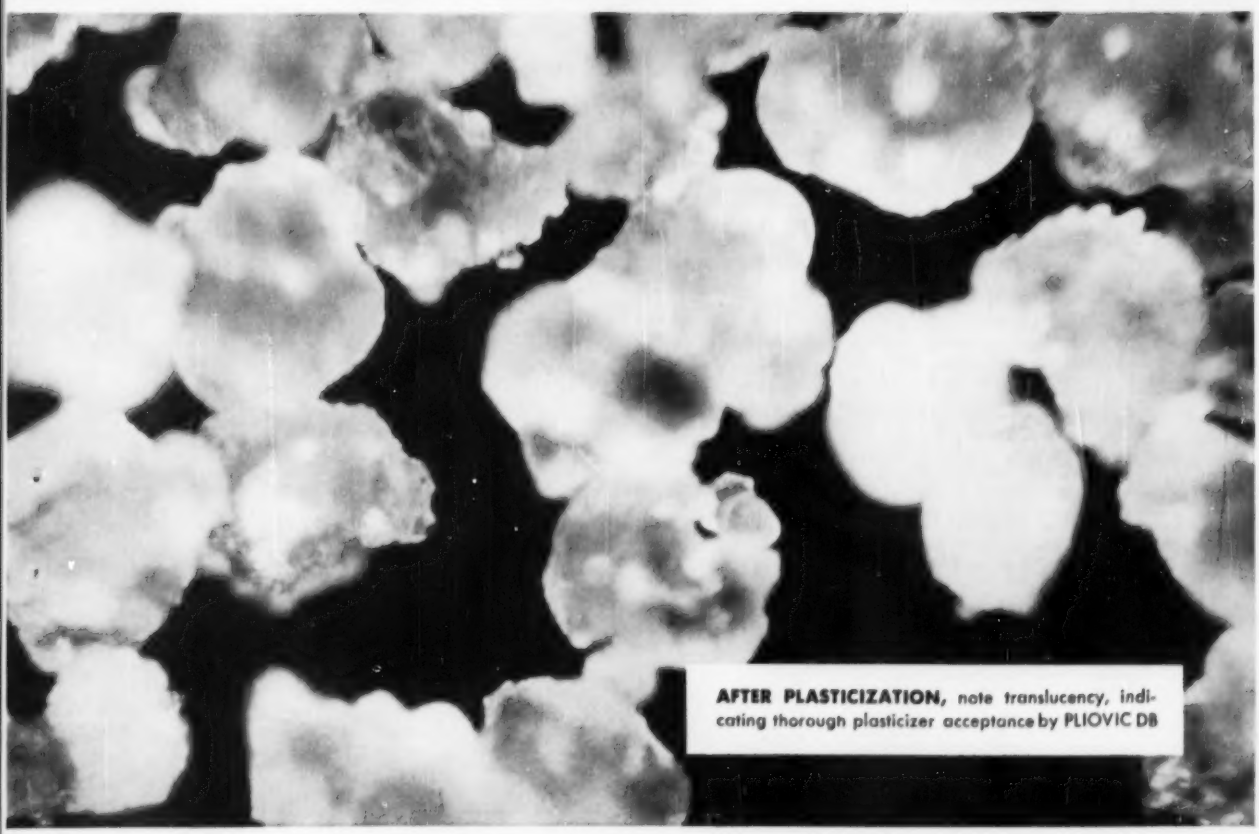
Plastics Department

CHEMIGUM • PLIOFLEX • PLIOLITE • PLIO-TUF • PLIOVIC • WING-CHEMICALS

High Polymer Resins, Rubbers, Latices and Related Chemicals for the Process Industries



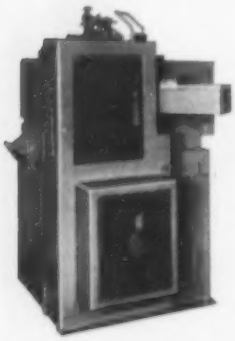
BEFORE PLASTICIZATION, note uniformity and porosity of particles of PLIOVIC DB resin



AFTER PLASTICIZATION, note translucency, indicating thorough plasticizer acceptance by PLIOVIC DB

CUMBERLAND
Plastics Size-Reduction Machinery

Cumberland "Stair-Step" Dicing Machines



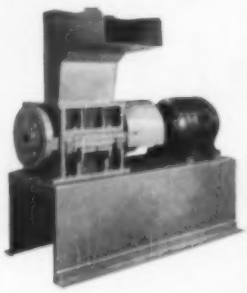
For dicing the *full range* of thermoplastic materials.

Cubes 1/16" to 1/2" produced from plastic sheet or ribbon stock. Pellet sizes altered merely by changing knives. Cubing is done in one severing operation with rotor knives cutting against one bed knife.

All surfaces contacting plastic materials are of corrosion-resistant metals.

Two sizes of machine available to handle sheets up to 7" and 14" in width.

Cumberland Model 20 All Steel Granulator

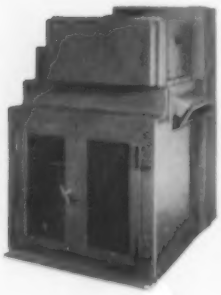


This heavy-duty all steel machine with 8" by 20" throat opening is suited for granulating tough plastic materials in the form of slabs, bleeder scrap, cylinder purgings, heavy cross-sectional parts, etc.

Frame and cutting chamber are of thick weldments with deep welds. Rotor and seal rings are heat treated and ground all over to provide tough, undamageable parts. Hardened surfaces preserve new appearance.

Machines resist wreckage. All inner surfaces are ground smooth to provide ease of cleaning.

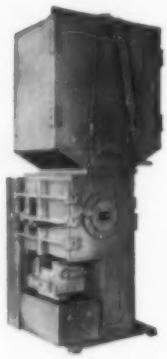
Cumberland Pelletizing Machines



A versatile machine designed for use as a pelletizer, chopper or dicer. As a pelletizing machine: cuts multiple extruded strands of plastic material into cylindrically shaped pieces or cubes for use in molding or extrusion machines. As a notched knife dicing machine: handles principally vinyl sheet stock. A less expensive dicing machine although less universal than the Cumberland "Stair-Step" Dicer. As a chopping machine: efficiently cuts rubber and vinyl slabs into small pieces.

Available in two sizes to handle stock widths up to 14" or 24".

Cumberland Pre-Breaker Granulators



Universal in its application, this dual rotor machine combines a pre-breaking machine and granulating machine in one compact unit. A large throat opening is provided to accommodate bulky reclaim as vacuum formed parts or trim. Also handles extra large and bulky parts and pieces of heavy cross-section as bleeder reclaim slabs, purgings, etc.

A special dome added to top of hopper makes machine ideal for long lengths of extruded pipe, rods, contours and similar items.

Unique hopper prevents any flyback.

Available in two sizes with 12" x 24" or 20" x 36" throat opening.

GRANULATING MACHINES
For Central Granulating and Use Beside the Injection Press

CUMBERLAND MODEL 0 — V-Belt or Direct Coupled (2 models)
For use beside each injection molding machine. Also for laboratory and miscellaneous uses.
Motor: 1½ or 2 h.p. Throat: 3¾" x 5½"

CUMBERLAND MODEL ½ — V-Belt or Direct Coupled (2 models)
For use beside each injection molding machine. Also for laboratory and miscellaneous uses.
Motor: ¾ h.p. Throat: 4" x 8½"

CUMBERLAND MODEL 1½ — Direct Coupled
For central granulating use.
Motor: 10 h.p. Throat: 5" x 12" or 8" x 11"

CUMBERLAND MODEL 10 — V-Belt Drive
For use principally beside the injection press.
Motor: 3 or 5 h.p. Throat: 6" x 10"

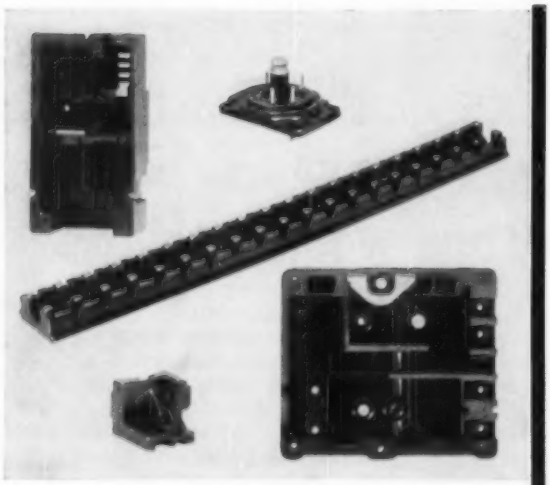
CUMBERLAND MODEL 18 — Direct Coupled
For central granulating use.
Motor: 20 h.p. Throat: 5" x 18" or 8" x 18"

CUMBERLAND MODEL 20 — (illustrated above)

CUMBERLAND FINE GRANULATING MACHINE
A machine for granulating to a higher degree of fineness than is possible with conventional machines.
Motor: 25 h.p.

Write for our Bulletin 260

talk about **know how**...



in plastics too... "Look before you leap."

Place your trust *on the shoulders* of a resource who knows one job best . . . *molding thermosetting plastics.*

At Kurz-Kasch, you can be sure of strong backs and keen flexible minds. They tell you quickly whether your part can best be molded in one of the basic phenolics or if the newer Teflon or glass-reinforced polyesters would serve you better.

And, most important of all . . . *dependability* is a Kurz-Kasch keyword. They never *bounce* from one quotation or one delivery schedule to another. They deliver to your specifications . . . with precision.

Designing, moldmaking, production are all *on solid ground* . . . all in one plant.

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REINFORCEMENT News from L·O·F GLASS FIBERS COMPANY

Inspection of preform before molding. Polyester resin is added and final cure made at 1300 PSI and 235°F. The high pressure is used to assure uniform density and smoothness!

Garan® Roving gives domes of Conoco pumps maximum translucency and weatherability!

"The favorable preforming and molding characteristics of L·O·F Glass Fibers' Garan Roving were essential in preforming domes for gasoline pumps that Tokheim Corporation manufactures for the Continental Oil Company. Garan Roving enabled us to make a part with maximum translucency, clarity of color and weatherability . . . with minimum fiber pattern."

Armored Plastics Division
City Auto Stamping Co.
Toledo, Ohio

R. S. Bevelin

L·O·F Glass Fibers' exclusive Garanized Roving imparts great flexural and tensile strength to reinforced plastics. It bonds strongly and uniformly with polyester molding resin. Such plastics, reinforced with Garan Roving, are stronger and have higher wet-strength retention.

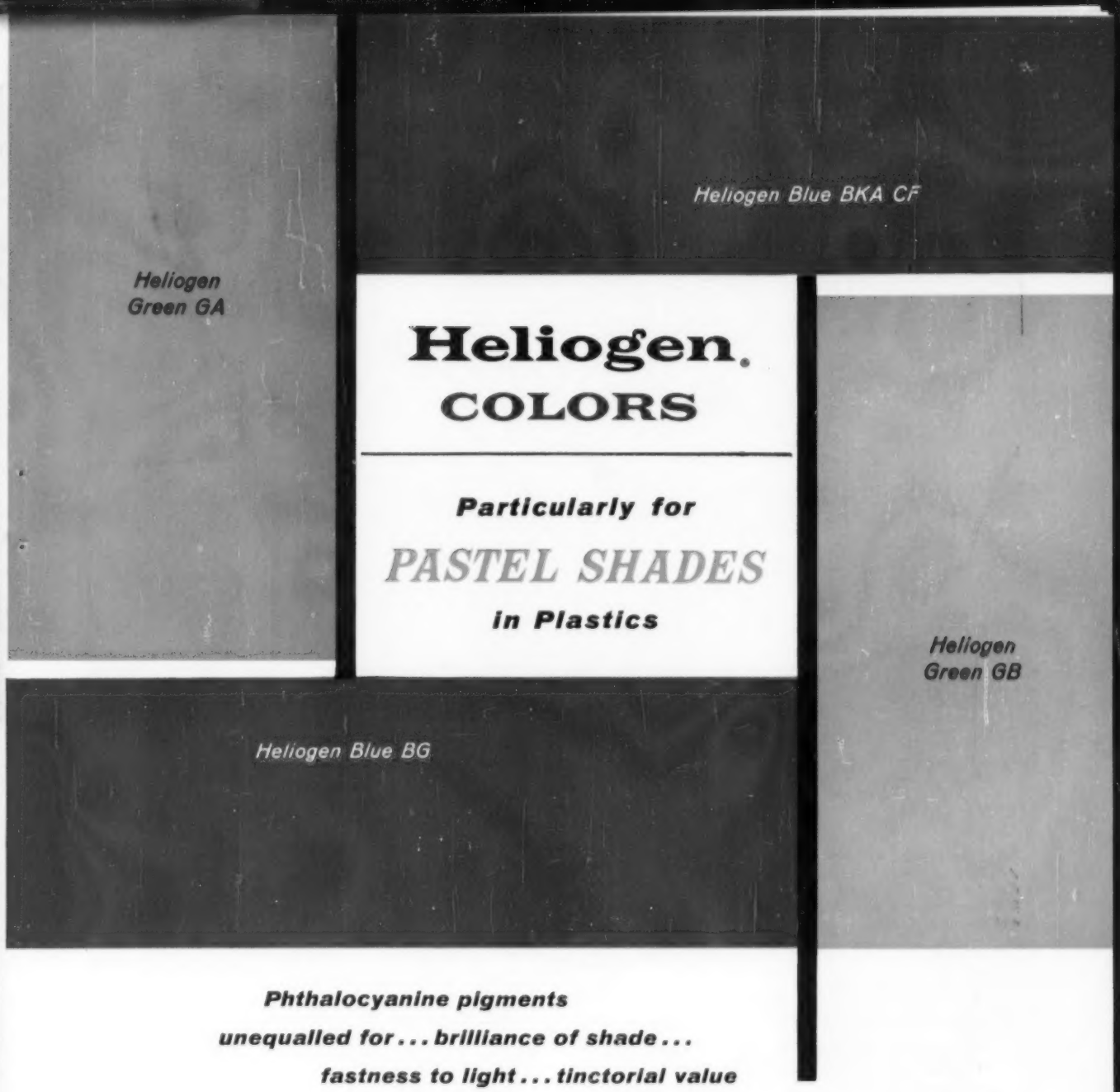
For many molding applications with epoxy, silicone and polyester resins, Vitron Roving is finding wide use.

For technical counsel on how Garan or Vitron Roving can improve your product, get in touch with our nearest sales office, or write: L·O·F Glass Fibers Company, Dept. 15-26, 1810 Madison Avenue, Toledo 1, Ohio.

LOF GLASS FIBERS Garan ROVING

L·O·F GLASS FIBERS COMPANY

TOLEDO 1, OHIO



Heliogen. COLORS

Particularly for

PASTEL SHADES

in Plastics

Phthalocyanine pigments unequalled for... brilliance of shade... fastness to light... tinctorial value

Heliogen Colors are supplied in powder or presscake form—according to the user's requirements. Compounders of plastics—and particularly the Vinyl plastics—standardize on these colors for their ease of handling, their chemical stability and their brilliance. (This page was printed with inks made from the Heliogen Colors as indicated.)

The powders are noted for ease of grinding. The corresponding presscakes flush readily into the plasticizers normally used. All are non-crystallizing in the presence of aromatic solvents—with the exception of Heliogen Blue BKA Powder CF. All are relatively heat stable—particularly the Heliogen Blue BG Powder which is outstanding in this respect.

To help you meet your particular requirements as to qualities, method and ease of application, let us send you our free new specifications booklet on Heliogen Colors—or call on the services of our Technical Department. Please address your inquiry to Department 49.

From Research to Reality

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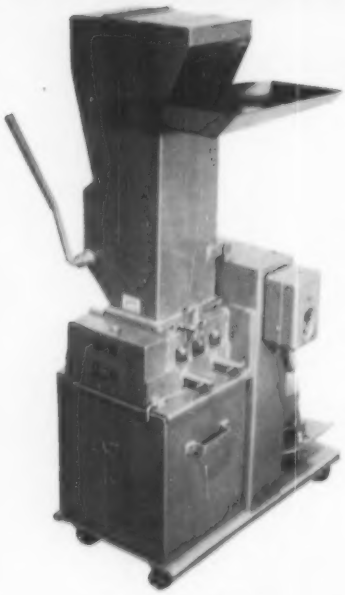
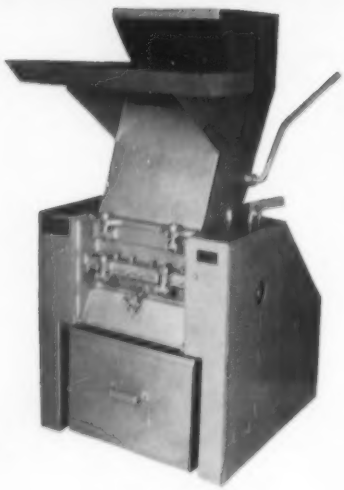
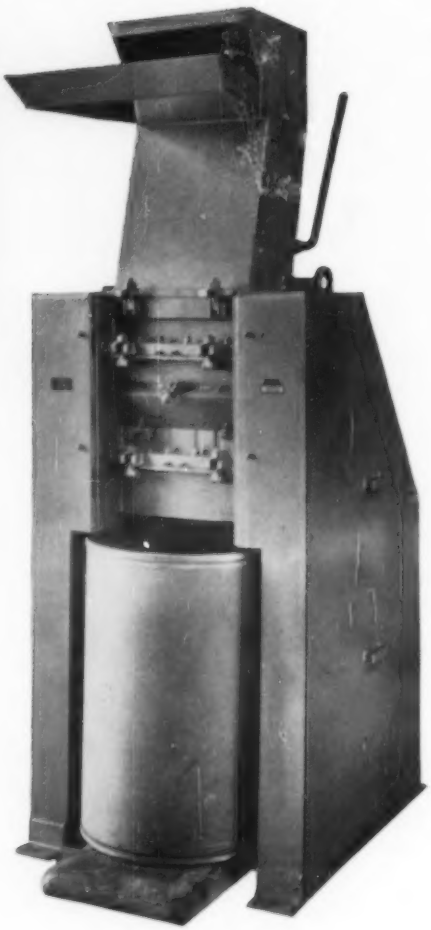
HERE'S HOW IMS MOLDER DESIGNED SCRAP GRINDERS SAVE YOU MONEY!



IMS Model M-4
All-Purpose Beside-the-Press Sprue Grinder. 5⅛" x 8½" Throat. Priced at $768.50. Complete with 2 HP Motor and Starter.



IMS Model M-40
Single Stage 11 x 17 Throat. Priced at $1795.00. Complete with 7½ HP Motor.



IMS Model M-400
Two-Stage—High Output. Priced at $2975.00. Complete with 10 HP Motor.

Don't let this little photo fool you! This is a BIG Grinder

Take the M-400 at right above—it replaces 2 to 3 conventional grinders. Labor saving? Of course! It does with 10-15 HP what other machines do with 40-50 HP in only 1/5 the floorspace. Or the M-40 (center). It pays for itself in short order in scrap and labor saved because its large 11 x 17 throat takes **BIG** moldings right at the press. And the handy, compact M-4 All-Purpose Grinder (left) gobbles up those round, hard-to-grind parts because the built-in throat clearing bar allows the operator to force them down into the cutting chamber **safely.**

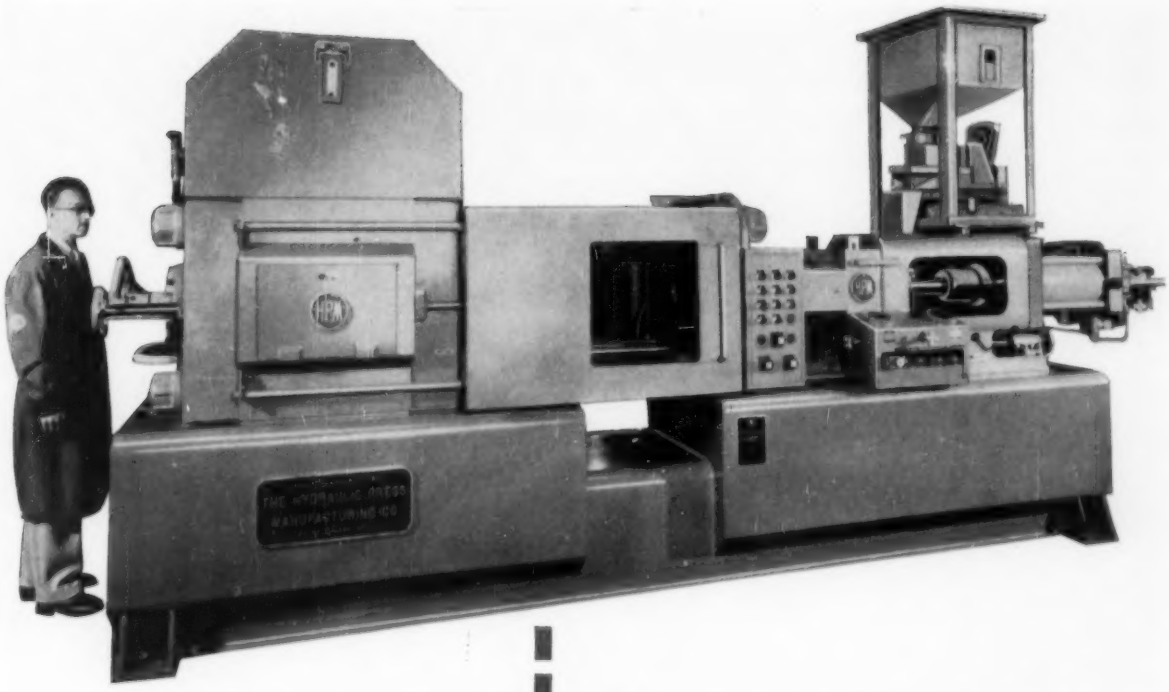
Still other **molder designed** features cut maintenance cost: blades are uniform and interchangeable on the M-4, M-40 and M-400! Screen assemblies are **REINFORCED,** and lift right out for easy cleaning. Compare IMS grinders! You'll see they are built to **practical specifications,** and are already setting **NEW STYLES** in grinder design. Many IMS features are being copied, but **only** on IMS Grinders do you get **ALL YOUR IDEAS BUILT RIGHT INTO ONE MACHINE!** Result? Your IMS Grinder installations will pay for themselves within a few months!

Order Today! Prompt Delivery. Complete Specifications on Request.

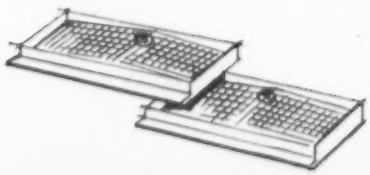
IMS

injection molders supply company

3514 Lee Road WYoming 1-1424 Cleveland 20, Ohio



"We Rely 100% on H-P-Ms"



H-P-Ms are built in sizes from 6 to 400 ounces with mold clamping forces from 150 to 3000 tons. Write for Bulletin 5601, today.

"Our H-P-M "12" Is Tops For Intricate Molding Jobs"

HUGH HALL, President, Therm-O-Plastic Products, Inc., Urbana, Ohio

Fine detail, like this record player grill, is a cinch for the H-P-M 12 oz. injection molding machine. This new H-P-M is fast, with 1150 cu. in. per minute injection, 135 lbs. per hour plasticizing capacity (polystyrene) . . . has extra large platens for family type molds . . . plenty of daylight and stroke . . . and straight line hydraulic mold clamp for easy mold set-up.

Why not take a tip from Therm-O-Plastic Products and check on what new high-speed H-P-M injection machines will do for you. They have five new H-P-Ms (6, 12, two 20s and a 48 oz.) working around the clock molding a great variety of parts.

HPM

PLASTICS DIVISION

THE HYDRAULIC PRESS MFG. CO.

Mount Gilead, Ohio, U.S.A.

DURAMOLD . . .

FOR ECONOMY IN COLD-HOBBING

Use of one of Bethlehem's three grades of Duramold tool steel is a good way to be certain of economy in cold-hobbing plastic dies. Duramold comes in grades A, B and C. No matter which grade you choose, you'll get tool steel which is relatively clean . . . free from surface and internal defects . . . capable of producing dies which take a mirror-like polish.

DURAMOLD A, air-hardening. This grade develops high core-strength (RC-30) after heat-treatment. It is annealed to a softness of 109 max Brinell. An easy steel to hob, and after carburizing, the smooth surface can be polished to a rich lustre.

DURAMOLD B, oil-hardening. Features an ideal combination of high core-strength and ease of hobbing. This grade is annealed to 100 max Brinell. An addition of boron effectively increases the core-strength, with no detriment to hobbing.

DURAMOLD C, water-hardening. A low-carbon steel. Of the three Duramold grades, this is easiest to hob, as it is annealed to 90 max Brinell. A case hardness of approximately RC-62 can be developed after carburizing and heat-treating.

In addition to the cold-hobbing grades, Bethlehem produces a full line of machined cavity and master-hob steels. To obtain full information about any of these long-wearing grades, all you need do is get in touch with your Bethlehem tool-steel distributor. Or drop a line to the nearest Bethlehem sales office.

BETHLEHEM STEEL COMPANY
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On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM TOOL STEELS

BETHLEHEM STEEL

egg beaters *on the go with* Plenco

Hard and heavy is the wear taken by such essentials as today's lustrous kitchen tool handles and precision aircraft starting devices. Wherever extreme rigidity and strength is demanded, industry is turning to high quality phenolic plastics—and more users of extra-tough phenolics are turning to Plenco.

Through well-rounded experience and a concentrated program of research, rigorous testing, and special, problem-solving services Plenco has been successful in developing improved products—better production methods—lower production costs.

If the results obtained by other manufacturers and molders are any criterion, you'll find it worthwhile to contact us for a discussion of *your* production problem. There's a Plenco phenolic plastic to meet your need, and speed your profits.

PLASTICS ENGINEERING COMPANY
Sheboygan, Wisconsin

Serving the plastics industry in the manufacture of high grade phenolic molding compounds, industrial resins and coating resins.

PLENCO PHENOLICS
FOR BETTER PLASTIC PRODUCTS

Plenco #454
Bottle Cap Compound

Kitchen tool handles, aircraft instrument cases, bottle caps. Applications far removed from each other—all from the same material? Not quite. Each application requires its own formulation to best meet service conditions.

Plenco 454 is especially designed and compounded for the production of bottle caps. This application requires special considerations in connection with minimum odor, non bleeding character, high torque strength and appearance under high temperature rapid cycle molding conditions.

Plenco 454 excels in these characteristics and reflects accordingly the painstaking efforts involved in its development.

General Electric is just one of the many users of Radialloy-Tipped* Circular Saw Blades

Illustrated is a General Electric class being taught Textolite* plastics fabricating with a Radialloy-Tipped* Circular Saw Blade

Whatever your "tough sawing" problem may be, there's a Radialloy-Tipped* Circular Saw Blade available to do the job better, quicker, far more economically.

Write for prices and brochure on our complete line.

Manufacturers Representatives:
Some Select Areas Still Open. Write.

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SPECIALISTS AND LEADING MANUFACTURER OF CARBIDE-TIPPED SAW BLADES

Behind every Thermatron unit is RADIO RECEPTOR'S 34 years of experience in electronics

If your business involves fabrication of vinyl plastics, be sure the electronic welding equipment you purchase will do the job without improvisation, guesswork and nagging adjustment.

Thermatron supplies much more than the finest machinery of its type. You receive assistance in techniques from our engineers who have long experience with production problems similar to your own. They make detailed studies of your product and production goals, run tests on your own materials, are always available for consultation. The element of chance doesn't exist when you work with Thermatron!

There's a complete range of Thermatron electronic generators from ½ KW to 300 KW and precision presses with all degrees of automation to suit your need. Look into Thermatron responsibility now. Would you like a copy of our latest bulletin on plastic welding? It's #101

Thermatron Division

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Poly-Eth News from the Southeast

Sam Silberkraus
Los Angeles

Dick Bishop
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Pete Dornik
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Vic Denslow
Chicago

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Ohio

Reported by
DICK McALLISTER
Spencer "Poly-Eth"
Sales Representative

Paper coaters and flat film extruders are enjoying from 5 to 8% more usable width when extruding "Poly-Eth," because Spencer film grade resins do not "neck-in" as much as other polyethylenes. Injection molders here in the Southeast have reduced cycles by using faster flowing grades of "Poly-Eth." Inventory planning has been made easier for molders and extruders, thanks to Spencer's strategically located warehouses and fast, dependable delivery service.

Southeastern vacuum formers are showing an increasing interest in the versatile sheeting characteristics of "Poly-Eth."

Our "tailor made" resins are solving many problems in this area. More and more processors are trying "Poly-Eth" in a variety of applications and reporting excellent results.

Spencer Chemical Company maintains a highly trained staff of technical service representatives. We have specialists in plastics, industrial chemicals and agricultural chemicals. These men are immediately available to assist in solving your technical problems.

Perhaps "Poly-Eth" or a Spencer technician can boost profits for you. Why not drop us a line?

SPENCER CHEMICAL COMPANY

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WEST COAST SALES AGENT: Riverdale Plastics and Chemical Company, 8510 Warner Drive, Culver City, California, TExas 0-1000

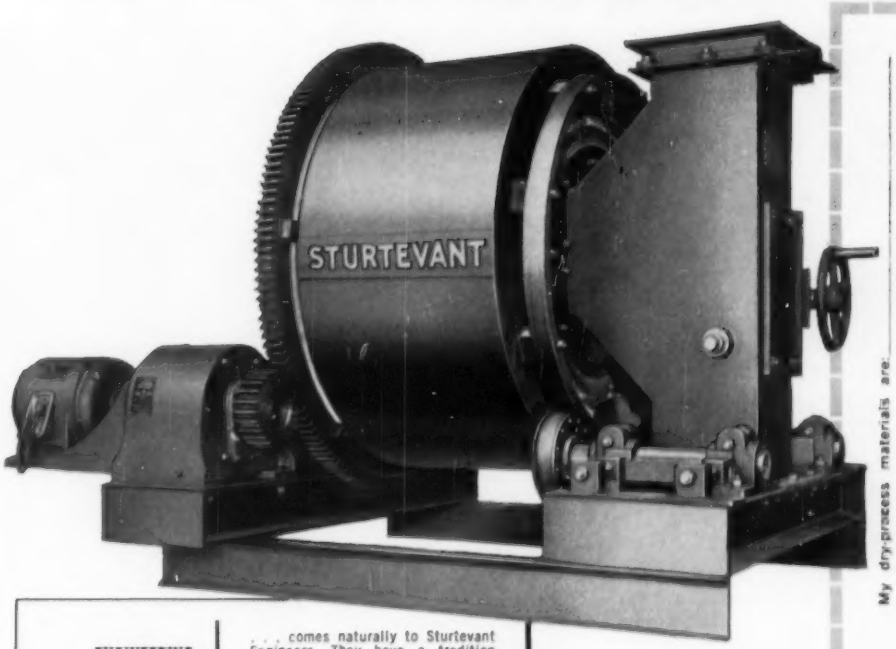
WAREHOUSES: New York City; Chicago; Los Angeles; Orange, Texas

Poly-Eth *by* **SPENCER**

Look for our new series of national ads promoting polyethylene uses.

SPENCER

COSTS OF BETTER BLENDS CUT TWO TESTED WAYS



ENGINEERING BLENDING AND OTHER DRY PROCESSES TO SPECIFICATIONS

. . . comes naturally to Sturtevant Engineers. They have a tradition of solving dry-processing problems since 1873. Sturtevant custom-built equipment and plants are well-known for their low-maintenance-cost operation. If your problems include any of the processes listed on the coupon, it will pay you to investigate.

Sturtevant Dry-Batch Blenders:

1. **SPEED UP PRODUCTION WITH 4-WAY MIXING**
2. **SHORTEN SHUT-DOWNS WITH "OPEN-DOOR" DESIGN**

Batches from 500 to 40,000 pounds come out of Sturtevant Dry-Batch Blenders exactly as you want them. They are completely blended regardless of the varying weights, densities or fineness of the different ingredients. And no dust is lost in the process. **Four different vertical and lateral mixing actions** inside the sealed rotating drum achieve thorough blending in minimum time. Single lever control of a single gate speeds up loading and discharging.

"Open-Door" accessibility makes cleaning and maintenance a matter of minutes. This original Sturtevant advantage plus 75-year-tested rugged construction assures more output per machine-year. Check the coupon for more information.

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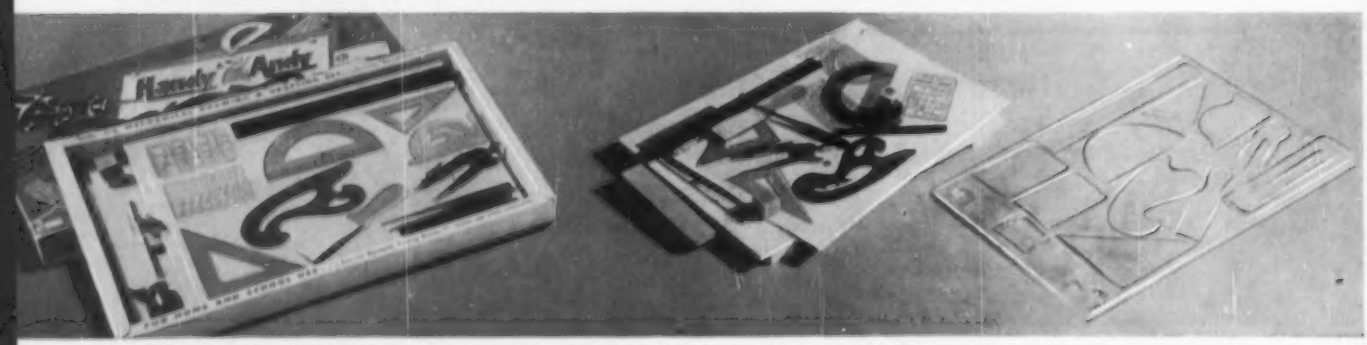

Skil-Craft Handy Andy package by Arrem Plastics, Inc., Chicago 12, Ill.

Celanese Corporation of America, Plastics Division, Dept. 101-B,
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One of the hottest merchandising ideas today is vacuum forming with acetate sheeting. Extruded Celanese acetate sheeting is transparent, tough and rigid. These properties plus its unique adaptability to deep draws make it ideal for production of formed displays, contour, blister and skin-formed packaging.

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"Then there's the toy gun mold. The parts are 34 inches long—about 132 square inches. Imagine running a mold like that in a 12-ounce machine. But we do it on our Lesters."

—Bill Byrd, Byrd Plastics, Inc., Erie, Pa.

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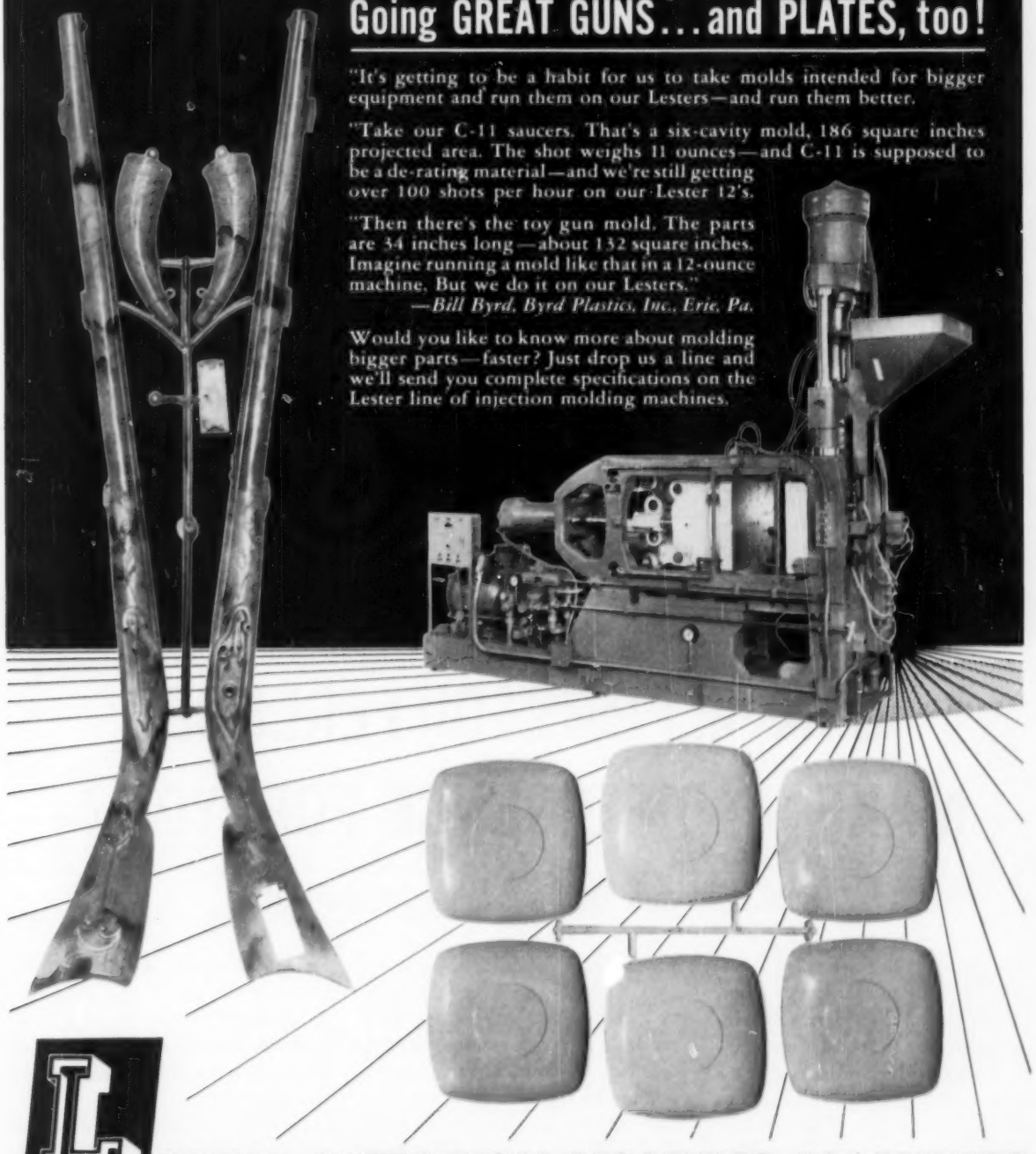

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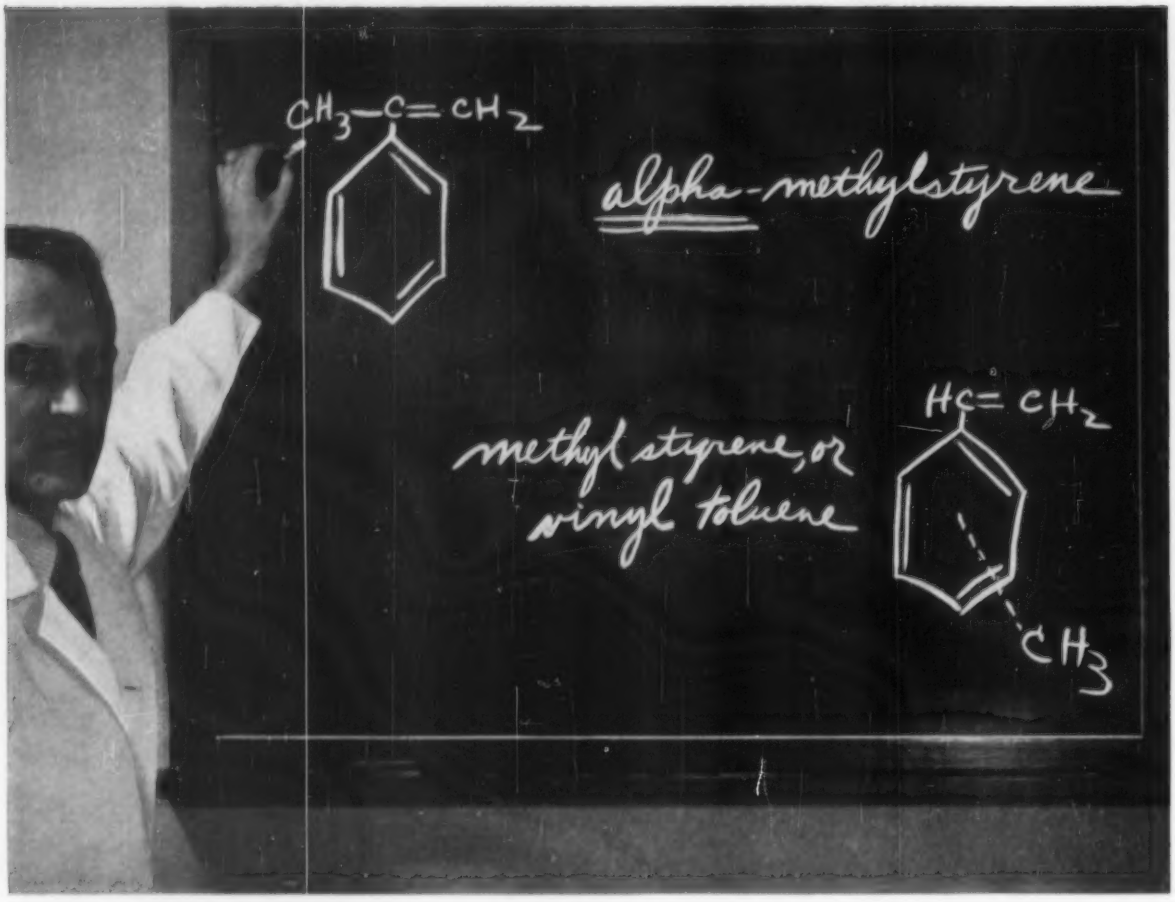

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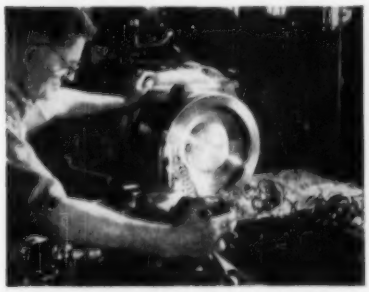

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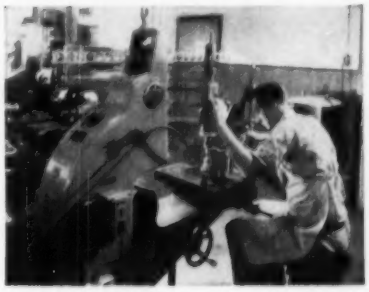

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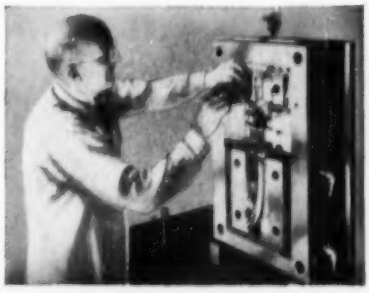

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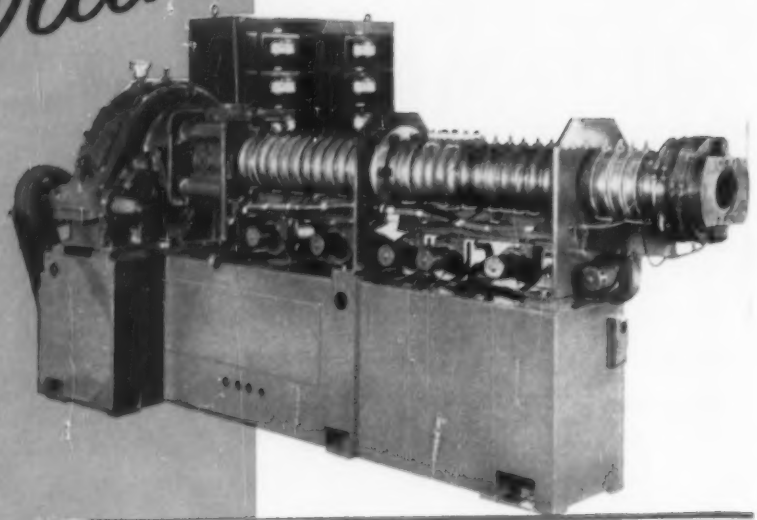

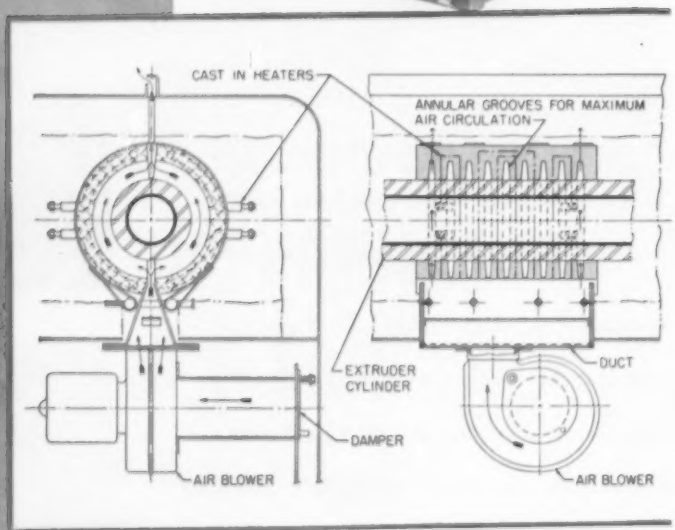

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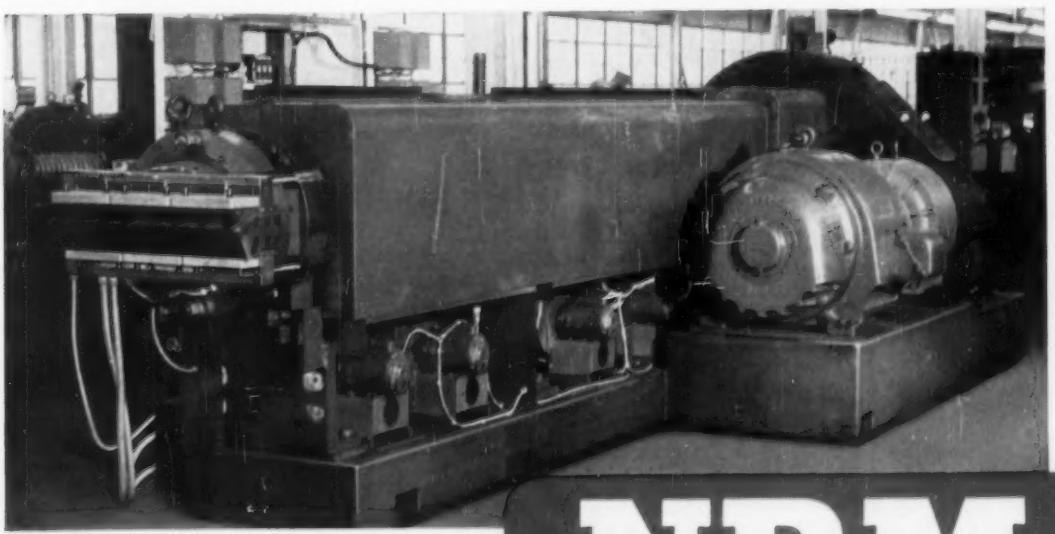
It's ECONOMICAL — NRM's Balanced Heat Control costs little to operate. Its only power requirement is electricity for blower motors, of which there is only one to each heating zone. Its economy, together with the better quality and more *accurate* extrusions it makes possible, are just more of the many PLUS reasons why NRM Extruders with exclusive Balanced Heat Control assure a higher ratio of profit from thermoplastics extrusion.



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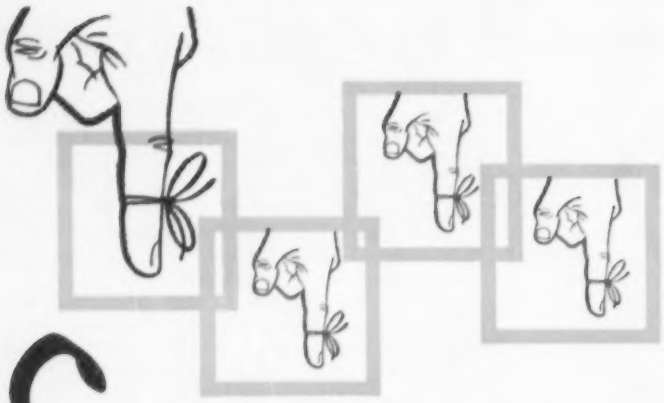

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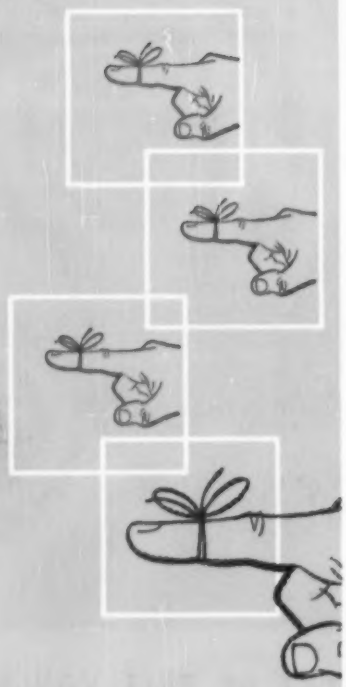

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The Plastiscope

News and interpretations of the news By R. L. Van Boskirk

Methacrylate price reduction. The 9% cut in methacrylate molding powder prices announced by Rohm & Haas (and quickly followed by a price cut by Du Pont) is the third reduction in 18 months. In 1954 the price for colorless was 68¢ a lb. f.o.b. In March 1955 the price was cut to 65¢ delivered. The new price is 59¢. Rohm & Haas has invested over $20 million in new facilities to help bring about these price reductions.

Extrusion possibilities increase. An interesting difference in the two announcements of methacrylate price cuts was that Du Pont included in its statement a price reduction from 60 to 55¢ a lb. for its "granular" polymers, used only for extrusion or compression molding. Granular polymers, in comparison to the much larger pelletized injection-grade material, are almost as small as grains of sugar. Du Pont is determined to increase use of extruded methacrylate sheet. Price reduction is one step in this direction. The company has spent years developing an extrusion method to minimize trapped-in stresses so that a sheet may be extruded which will not shrink more than 2½% in a forming oven and will give a uniform caliper range that will not deviate more than 5 mils from goal thickness. Du Pont thinks thin extruded methacrylate sheet can be produced which is equivalent to cast sheet except for the high degree of optical qualities needed in aircraft applications but which is perfectly suitable for lighting, signs, partitions, and similar uses.

Significance of methacrylate price dip. Methacrylate producers are out after bigger game. There would seem to be little reason for reducing prices unless a broader market seemed available at a lower price level. Perhaps more can be used for automobiles, where the present average is at least 1½ lb. per car; and there are doubtlessly other molded items within reach since price is now competitive with plastics in the medium-price range. Molding powder price is still above that of polystyrene (at 30¢) which also has the advantage of a 10% lower specific gravity. But methacrylate sheet made from 55¢ material may eventually compete successfully with various plastics sheet materials on a cost and properties basis. An announced 32¢ monomer price, down from 35¢, also bears watching—at that price it is no longer a luxury item. The lower monomer price means tighter competition with other plastic monomers—and at the same time a likelihood of more methacrylate monomer use in paints, adhesives, finishes, and reinforced plastics.

Vinyl price drop. Vinyl chloride resin prices were reduced by Bakelite from 31 to 27¢ a lb. for VYNW resins, used in calendering and wire insulation. The price for VYHH resins used in can linings, paints, records, and floor tile was reduced from 35 to 32 cents. Bakelite-produced film was reduced 1½¢ a lb. in thicknesses up to 12 mils; 12 mils and over was reduced 2 cents. This is the second substantial reduction for vinyls in seven months. At this time a year ago, the standard price was 38 cents. The price for foreign resin, delivered, is generally about 28¢, counting tariff, commission, and freight.

Polyethylene wire coating. Early estimates for 1955 now seem very low. A later recapitulation indicates some 50 million lb. or more was used for that

• Reg. U. S. Pat. Off.

purpose. On the other hand, the MODERN PLASTICS estimate of 130 million lb. of resin used in film seems at least 5 million lb. high. All estimates were made in October; revisions will be necessary as the business picture for the year unfolds more clearly.

Melamine dishware. 1955 business went far ahead of most predictions. Total is now believed to have been around 24 million pounds. Some analysts estimate that it was about 35% higher than in 1954.

Another polyethylene distributor. Catalin Corp. is now selling general-purpose polyethylene from its warehouses scattered around the country. The material is labeled Molding Compound 15-5 and sells for 41¢ a pound. Catalin has not identified the maker of its resin but states that it will soon have a complete range of formulations for special applications.

Another polyethylene formulation. Bakelite has added another molding compound to its long list of conventional polyethylene formulations. It is called DXM-103 and sells for the standard molding material price, 41 cents. It has a greater density than standard polyethylene, but is no relation to the much talked about low-pressure materials. It is a competitive material to the polyethylenes that gained rapid recognition last year for use in large housewares items such as waste baskets. Of special significance in the new formulation is the high gloss it gives to the molded piece because of its excellent flow in the mold. The easy flow also eliminates the undesirable flow line characteristics of ordinary polyethylene molding resins.

German plastics institute. Interesting news from Germany is the construction of a new building at Darmstadt to house a Plastics Institute, an organization for which there is no counterpart in the U. S. The director is Dr. Leo Kollek. The Institute grew out of an association of 189 plastics groups and other organizations interested in plastics. The Institute will study structure and quality of plastics, test methods, standardization, and training of youth. German plastics production rose from almost zero in '45 to 680 million lb. in '54.

Solvic plants around the world. In 1949 the first Solvic group was started in Jemeppe-sur-Sambre, Belgium. By 1957 the total capacity of all its plants will be 110 million pounds. The company now produces PVC by both the emulsion and suspension processes and some vinyl chloride-acetate copolymer. When the new Belgium plant is completed in 1956, capacity there will be 30 million pounds. The French plant capacity is 48 million lb.; in Italy, 18 million lb.; in Austria, it will soon be 7.2 million lb.; in Spain, facilities to be completed in 1956 will produce 4 million pounds. Total capacity of an establishment to be opened in Brazil late this year will eventually be 8 million pounds.

Fluorcarbons for pipe. Kel-F pipe and fittings, as well as injection molded Kel-F linings for metal valves, are now being shown for use where other thermoplastics are impractical. They are suggested where high temperature and chemical resistance are problems. Stokes Molded Products has made fittings, General American Transportation both fittings and pipe, and Anesite has extruded pipe.

Report from Landes. W. Stuart Landes, formerly of Celanese, has been an industrial consultant to the U. S. Operations Mission in Japan for several months. In a letter to the publisher of MODERN PLASTICS Magazine he says: "The plastics industry is further advanced than the older industries in Japan. One company was given an Isoma injection machine smuggled in Japan by submarine in 1944 and told to duplicate it and get going. They now have about 40 injection machines ranging in size up to 32 oz.; the larger ones are all American.

Another plant of this same company just started operations producing extruded PVC pipe . . . it is the equal of anything I have seen in America."

Styrene monomer. Dow Chemical has reduced the price of styrene monomer used for synthetic rubber polyesters and styrenated paint from 17 to 16½ cents delivered. However, the styrene used for polystyrene, and generally used for lattices, high styrene-butadiene resins, and in metal to prevent porosity remains at 20½ cents. Dow spent $50 million for construction in 1955 and expects to spend $75 million in 1956. Among the facilities expanded in 1955 were those for saran, saran film, polystyrene, Styrofoam, and polyethylene.

Another melamine. A new brand of melamine powder, Demelan, is now produced in Vienna, Austria, by Vereinigte Chemische Fabriken Kreidl Rutter & Co. Both electrical and dinnerware grades are available. The company has developed its own process, has applied for a patent, and will license interested parties.

Epoxies on the move. An idea of how enterprising concerns have been diving into the epoxy resin business may be garnered by turning to page 254. Volume is still small—about 18 million lb. in 1954. The 1955 total is not yet available, but percentage for uses other than surface coating (tooling, potting, adhesives, and printed circuits) is increasing--has grown to perhaps 25 or 30% in 1955.

Stickems for hard-to-stickers. Teflon has always been notoriously difficult to fasten with an adhesive. In fact, it is often used where non-sticking is desirable, such as on rollers for bread dough. Du Pont has now devised a method of treating Teflon to obtain a cementable surface, thereby making it more useful as a liner for pipe, ducts, and valves. Nylon is another hard-to-stick plastic, but Ions Exchange Corp., New York, N. Y., claims development of a new cement that not only bonds nylon but also fills in gaps when joints are not matched. The cement is marketed under the name of Nylosil.

New vinyl plants. Escambia Bay Chemical Co. which will start producing vinyl chloride polymer about Jan. 1, 1957 in a plant near Pensacola, Fla., has set up the following top echelon of officers: K. J. Donald, now vice president of National Research Corp. of Boston, is acting president to succeed M. A. Abernathy, who died in November. David J. Stark, formerly manager of the National Petrochemicals Corp. plant at Tuscola, and once a chief technologist with Shell Oil, is vice president and plant manager. Dr. Nat C. Robertson is director of research and Dr. W. M. Smith, formerly of Firestone, is assistant director. Walter W. Peacock, Jr., who has been Naugatuck's assistant sales manager for vinyl the past year, will be sales manager of Escambia's polyvinyl chloride division. Temporary offices are now with National Research Corp. in Boston, one of the joint owners with United Gas and Electric Bond and Share. Escambia will purchase vinyl monomer for several years to come, but expects to eventually produce acetylene for vinyl monomer and other chemicals.

Roller patent vinyl. Over one million yards of polished or patent vinyl sheeting produced by a continuous belt method were sold in the U. S. in 1955 by Sommers Plastic Products Co., New York, N. Y. The company is sole distributor for the Alkor Plant, Munich, Germany. American patent vinyl is made by plate polishing and sold in sheet form only. Sommers asserts that it can now furnish patent vinyl in the same grains and embossings which are at present common to unpolished vinyl sheeting in thicknesses from 16 to 28 mils. Unembossed patent vinyl is available in thicknesses ranging from 8 to 40 mils.

Diversification pattern. Every large corporation in the U. S. seems bent on becoming larger, but there are scarcely two of them employing the same pattern of expansion. When Koppers purchased 80% of the Durethene stock, the deal

represented only a small part of its expansion program. The company spent $25 million in 1955 to acquire six companies, and will spend as much in 1956 as part of a 5-year program. Its chemicals division, the largest, accounts for 50% or more of the company's earnings and includes the plastics—polystyrene, polyethylene, and resorcinol. Another low-pressure polyethylene plant will be built jointly with Brea Chemical. The newly purchased companies produce container-making machinery; dyestuffs; jet engine and gas turbine equipment; filters for air cleaning; noise control equipment; and wood treating equipment. All of them fit into one of Koppers' six divisions. The purchase of Durethene fits neatly into this Koppers mosaic; but it leaves 25 or 30 film producers wondering about their future.

Did Koppers start a trend? When Koppers bought controlling interest in Durethene, one of the three largest polyethylene film producers, the immediate question in trade circles was whether or not other producers would start buying up film and molding plants that use polyethylene as a primary raw material. Early last year there was talk of a Monsanto-Visking merger, but any such deal has been vigorously denied by the principals. Also there are expert film producers of other plastics now making polyethylene polymer who could quickly become polyethylene film processors if they were threatened with loss of major customers. And there is always the threat of price cuts by major resin producers. This could complicate the competitive situation, with producers of resin vying with each other for film business. The end result could be like that in vinyl: mountains of film produced with meager profit or even losses.

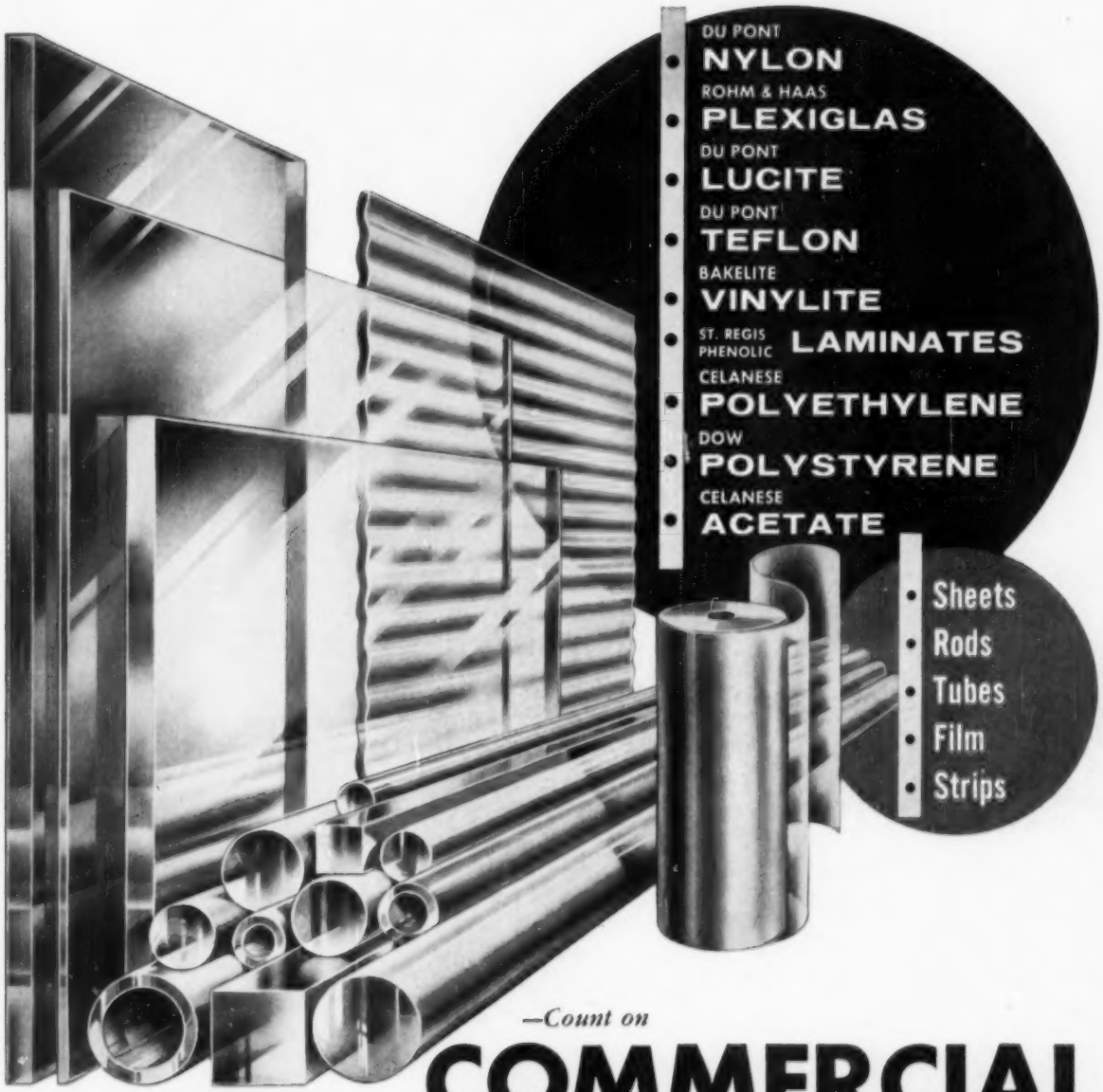
Combine interest in melamine. Negotiations are under way whereby Formica, one of the nation's largest-volume high-pressure laminators, will become a division of American Cyanamid Co. Formica will continue to operate under present management and will also go ahead with its 2½ million dollar expansion program at Evendale, Ohio, that will add 20% more laminating facilities. Reason given for the move was "merging will provide Cyanamid with national distribution channels to the consuming public." Formica sales in first three quarters of 1955 were $27 million, Cyanamid's were $336 million. Cyanamid is the original and the largest producer of melamine resin in the United States. Is also about to enter the thermoplastic field with a styrene type resin. Formica is a large-volume user of melamine for the production of decorative laminates. Some 10 to 15 million lb. of melamine is thought to have been used by laminators in 1955. Speculation is rife that Formica will eventually also enter the molding field using Cyanamid's melamine, urea and styrene.

New vinyl acetate plant. Air Reduction Chemical Co's. new 30-million lb.-a-year vinyl acetate monomer plant at Calvert City, Ky., went on stream this month. Total capacity in the U. S. is now estimated at 165 million lb. annually with another 60 million lb. available in Canada. About 140 million lb. of vinyl-acetate was consumed in the U. S. in 1955, of which 30 million came from Canada.

Uses for vinyl acetate. Of the 140 million lb. of monomer consumed in U. S. in 1955, an estimated 32 million was for alcohol; 35 million for butyral and acetal; 18 million for copolymer uses; 55 million for acetate polymer. Of the latter, estimated uses are 30 million lb. for adhesives; 10 million for textiles; 10 million for paint; 5 million for miscellaneous.

Vinyl stearate plant. Air Reduction's plans also call for a vinyl stearate plant of about 1-million lb. capacity at Calvert City, to come in some time this year. Vinyl stearate is primarily for use as a copolymer with PVC and PVA to provide a flexible material which needs little or no plasticizer.

For additional and more detailed news concerning the Plastics Industry, see p. 252



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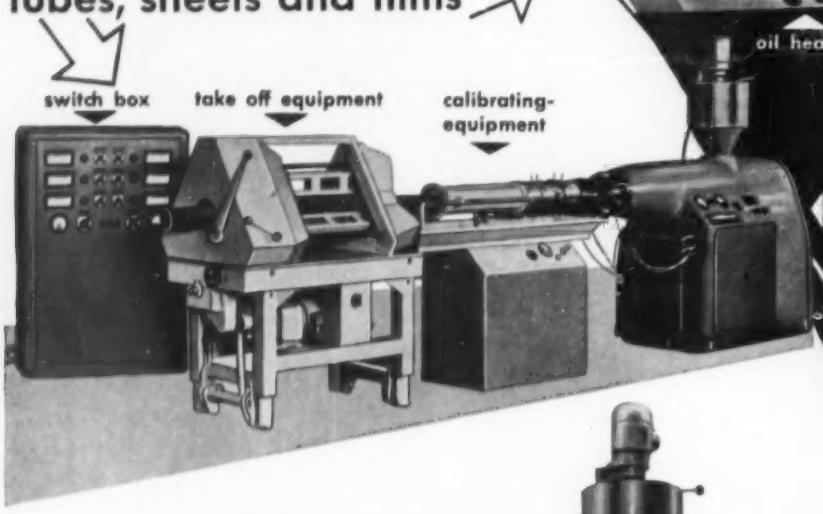
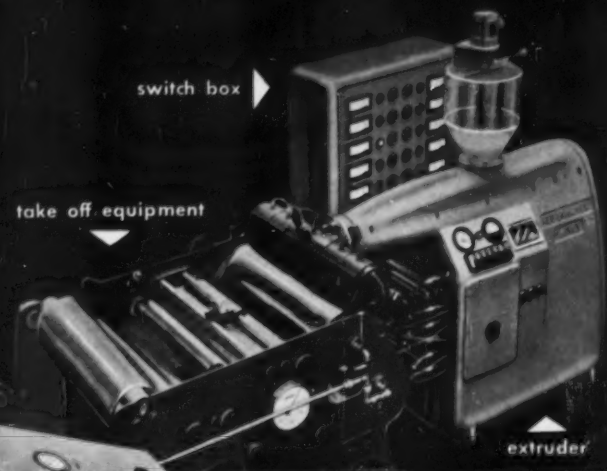
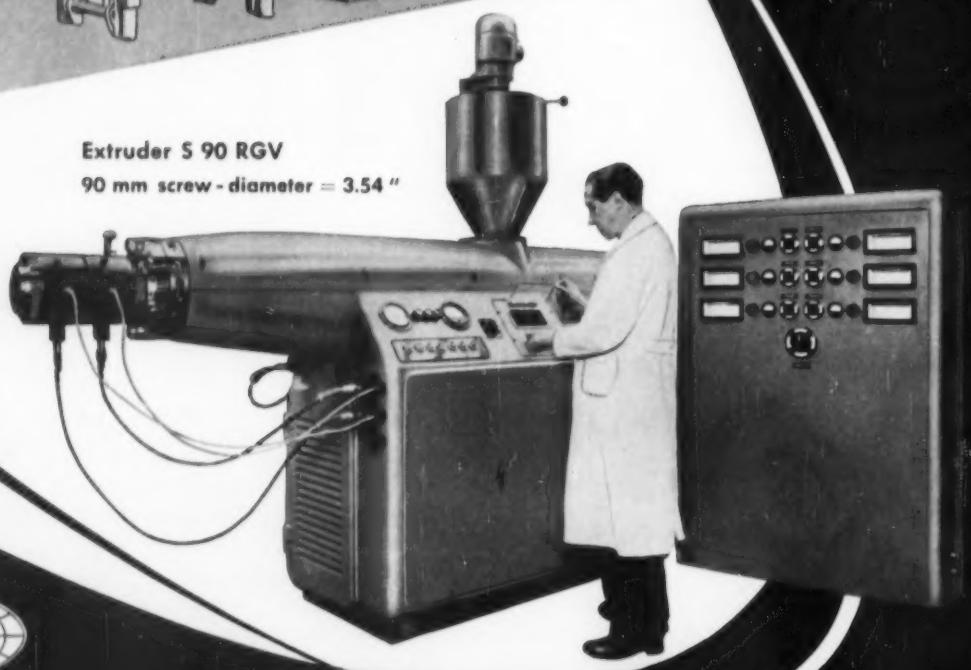




Extruder S 90 RGV
90 mm screw - diameter = 3.54 "



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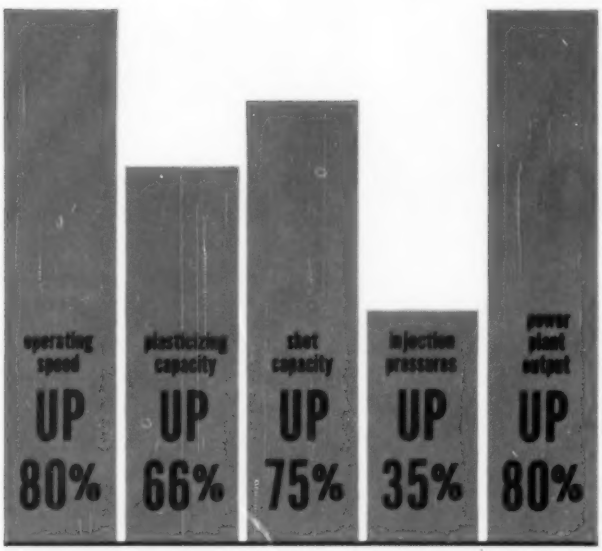

Write for BULLETIN 105, or call BEdford 2-2500, for additional details.

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Now you can create alloys for uses like

Special Industrial Finishes, such as the tough enamel lining of this Airslide car for shipping flour, are made possible by new Versamid-epoxy alloys. By blending these resins, you can get hard, tenacious finishes with outstanding resistance to moisture and many solvents, as well as alkaline solutions of up to 50% concentration. For more data on the properties of these alloys. Write for General Mills Technical Bulletin 11-D.

Bubble-Free Pottings and castings can be made with Versamid 125 and epoxy resin alloys. They offer lasting toughness and resistance to water, chemicals and most solvents. This resin alloy features low shrinkage, excellent thermal shock resistance, high physical and dielectric strength and freedom from noxious curing agents. Write for new bulletin.

Low-Cost Tools and Dies like these are now being made from thermosetting blends of Versamid and epoxy resin by Champion Aircraft Corporation, St. Paul, Minn. Versamid-epoxy alloys are hard, tough, impact-resistant—excellent for tools, jigs, fixtures, master molds and like items. With low shrinkage, they conform to the mold, give amber-clear, bubble-free castings, saving time and money for Champion and many other companies.

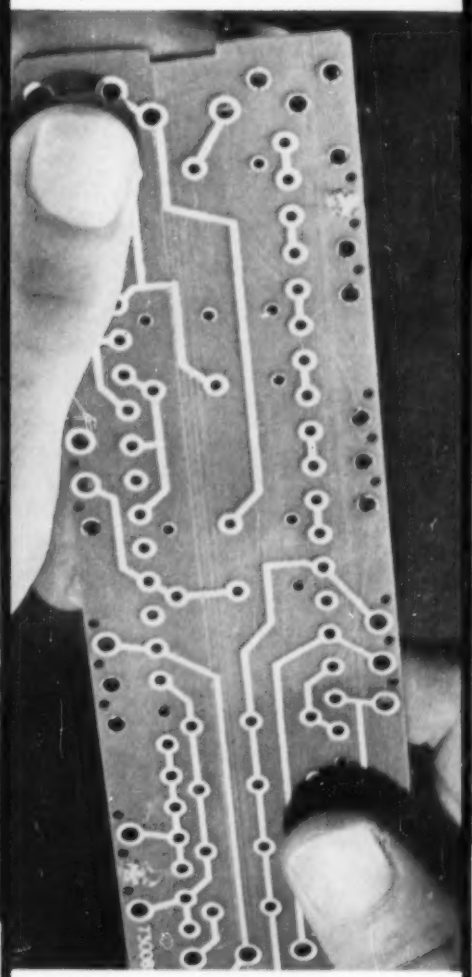
For more information, send for the new booklet, "Versamids . . . A Demonstration in Resin Versatility."

*Investigate **Versamids...***

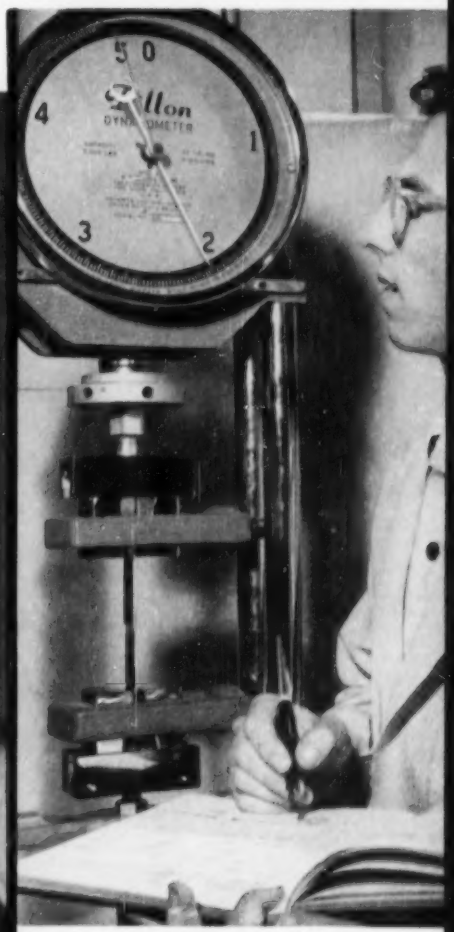
the versatile polyamide resins made only by...

exciting new resin these with Versamids!*

Rugged Laminations, such as the plastic boat above, are among the uses for Versamid-epoxy resin alloys. These blends laminate glass fiber cloth, mat or roving. They wet the glass thoroughly, resist delamination. Other possible uses include plastic pipe, radome materials, honeycomb panels and air frame components for aircraft.



Printed Circuit Bases like this are a new use for Versamid 115-epoxy resin blends. Toughness, adhesion, and resistance to corrosion make them ideal for this purpose. Another blend (Versamid 100 and epoxy) bonds electrolytic metals to the bases—with contact pressure only. Formulations appear in Technical Bulletin 11-E.



Load Bearing Adhesives much stronger than most commercial adhesives are made from thermosetting blends of Versamid 115 and epoxy resins. They bond almost any substrate to any other...including wood, steel, aluminum alloys, sheet glass, Plexiglas, Mylar and honeycomb core materials. They show top shock resistance and offer protection against water, grease and oil, chemicals and common solvents. Write for Technical Bulletin 11-F.

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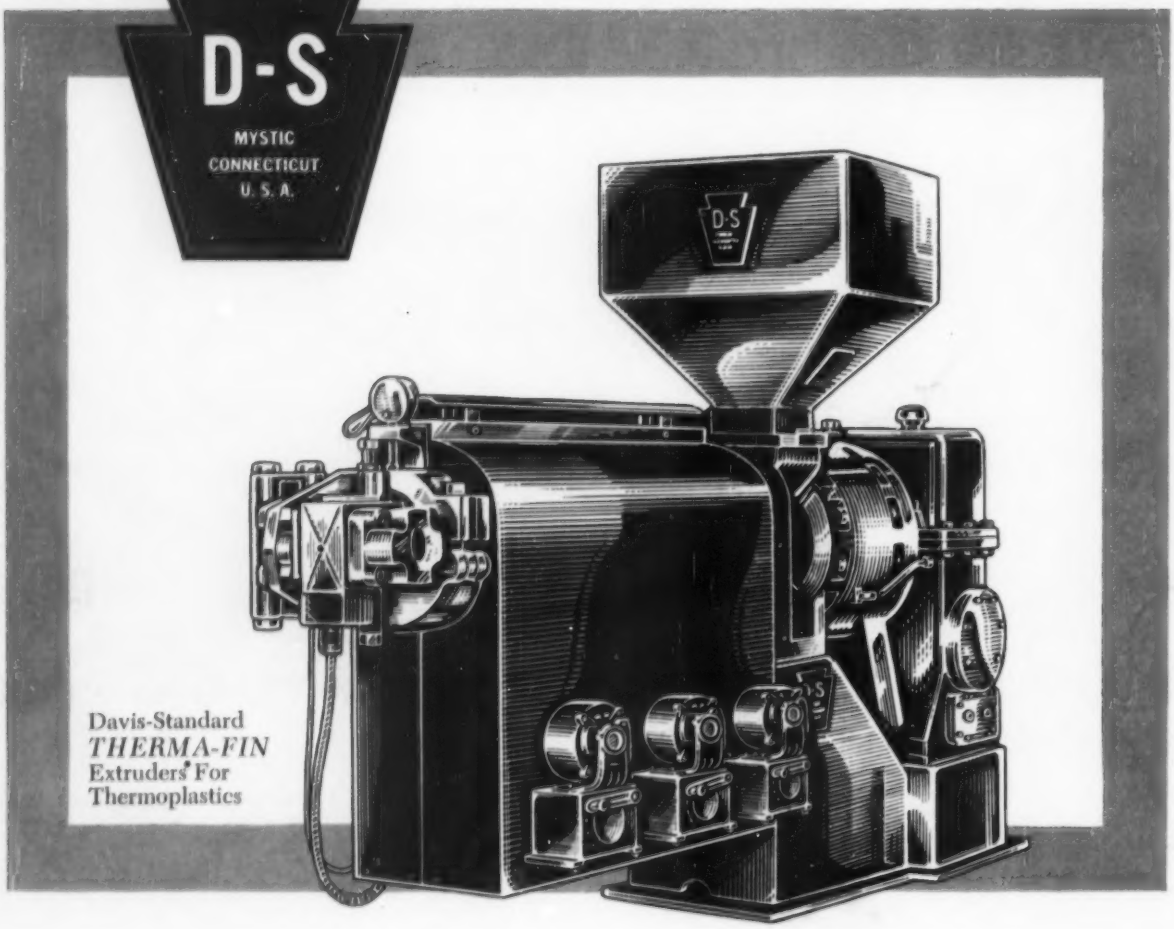

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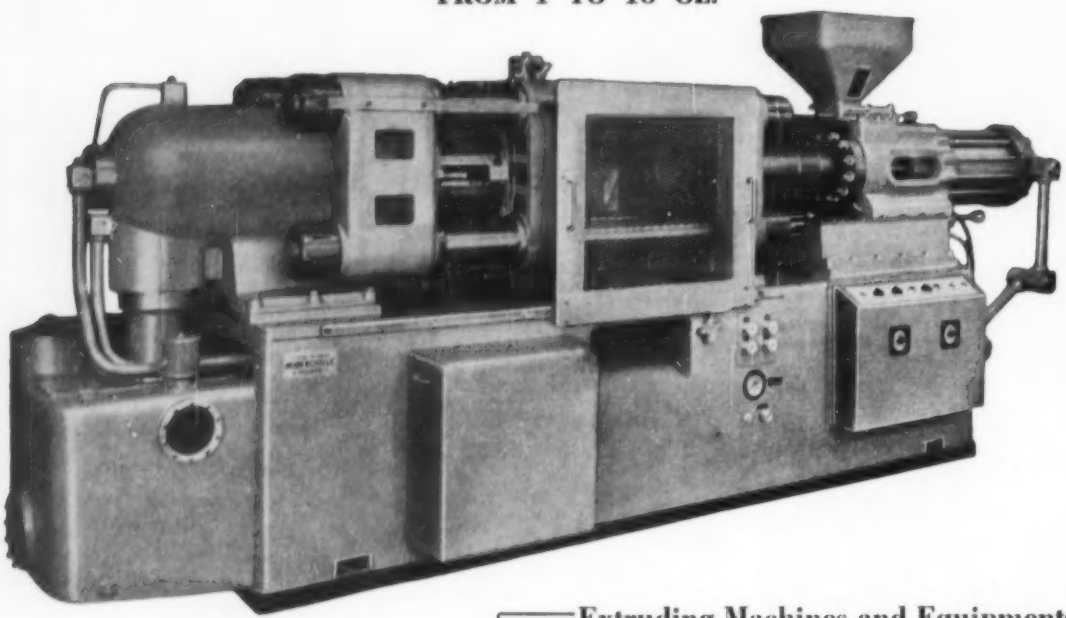
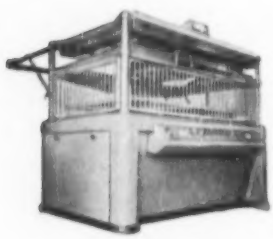
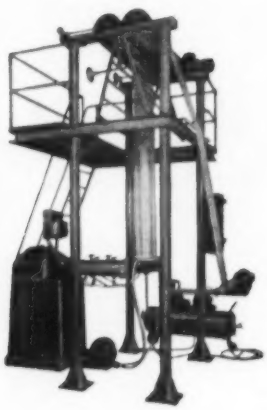


"Vuotoplast" – Vacuum Forming Machines



Extruding Machines and Equipments



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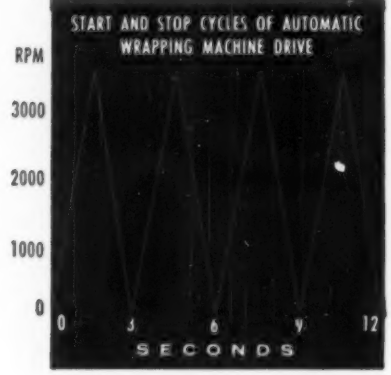

RELIANCE V★S DRIVE ®

The Dow Chemical Company's production of "Saran Wrap" has leaped from 130,000 rolls to 4,000,000 rolls a month since 1951. This up-swing is due to a new plant, a new flow system, and additional equipment including new machinery equipped with Reliance V★S Drives.

One of the most dramatic applications of V★S Drives is on the final wrapping machines shown here. The drives must be able to start, accelerate to 3500 rpm., and stop more than 20 times a minute.

The most important feature, though, is not the frequent starts and stops, but the delicately controlled acceleration of the drives. "Saran Wrap" is only 1/6th as thick as a human hair, and sharp or jerky starts will cause a break in the sheet and halt production. Reliance Drives do the job day in and day out without a single break due to uncontrolled acceleration.

This feature of V★S Drives, called *Dynamic Response*, is only one of the many facets of Reliance Drives. V★S Drives can regulate tension, synchronize operations, control speed rates, and automatically program speed changes.

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Write for bulletin D-2311.

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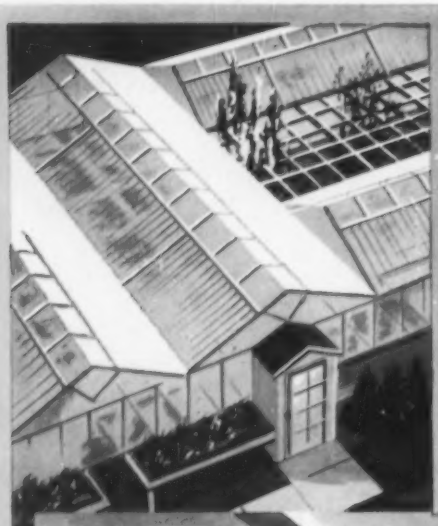

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PITTSBURGH'S SELECTRON Polyester Resins are playing an important part in the development of new materials for building and decorating. They are being used in the making of clear and colorful panels that have a wide range of applications—from sidelights and skylights of greenhouses to decorative partitions that add sparkle and beauty to office or home.

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SELECTRON Resins offer almost endless possibilities to alert, progressive manufacturers. If you are designing a new product—or redesigning one you are now making—SELECTRON may help you make it lighter, stronger, more durable and, probably, at lower cost. We'd be glad to have one of our engineers discuss your problems with you without cost or obligation.

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Baskets for automatic washers
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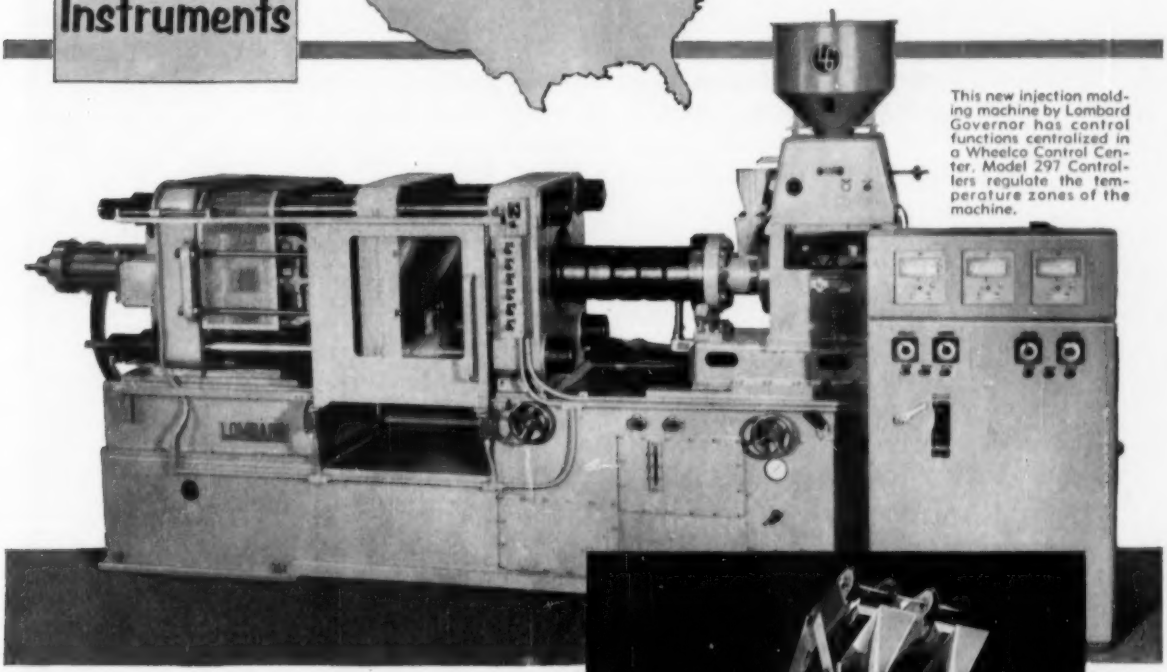
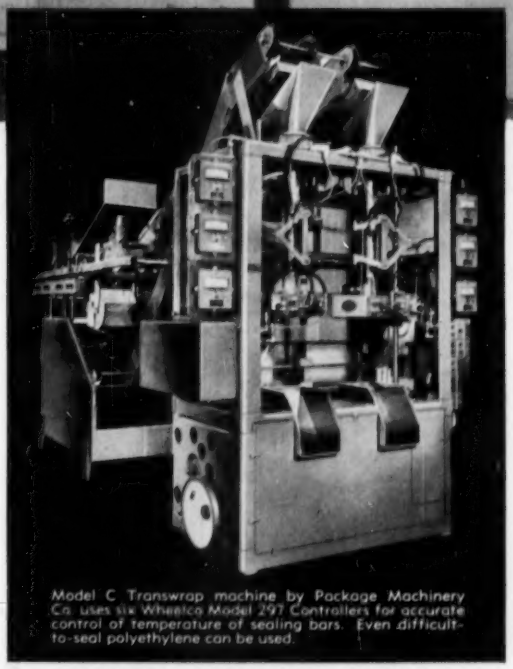


This new injection molding machine by Lombard Governor has control functions centralized in a Wheelco Control Center. Model 297 Controllers regulate the temperature zones of the machine.



Model C Transwrap machine by Package Machinery Co. uses six Wheelco Model 297 Controllers for accurate control of temperature of sealing bars. Even difficult-to-seal polyethylene can be used.

Wheelco has built an enviable reputation in the plastics industry, based on a solid foundation of expertly engineered instruments, dependable service, helpfulness in training personnel and ready assistance in system design.

You can rely on Wheelco at every stage of production. A field engineer will be glad to assist in the selection of instruments for a temperature control system or Control Center. Wheelco sales and service offices are located in all principal cities and carry stocks of instruments, repair parts, and thermocouples.

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Pumps tricky latex compounds without coagulation

with rotor shafts mounted on TIMKEN® bearings

THE Marco Company, Inc. of Saginaw, Michigan, has found a wide range of applications for its Model AC Flow-Master Commander Pump, operating in some cases up to 1000 psi. These include the pumping and metering of sensitive latex compounds, which become coagulated with even the slightest friction or agitation. Yet the Flow-Master Commander avoids this, by maintaining close tolerances and positive displacement with rotor shafts mounted on Timken® tapered roller bearings.

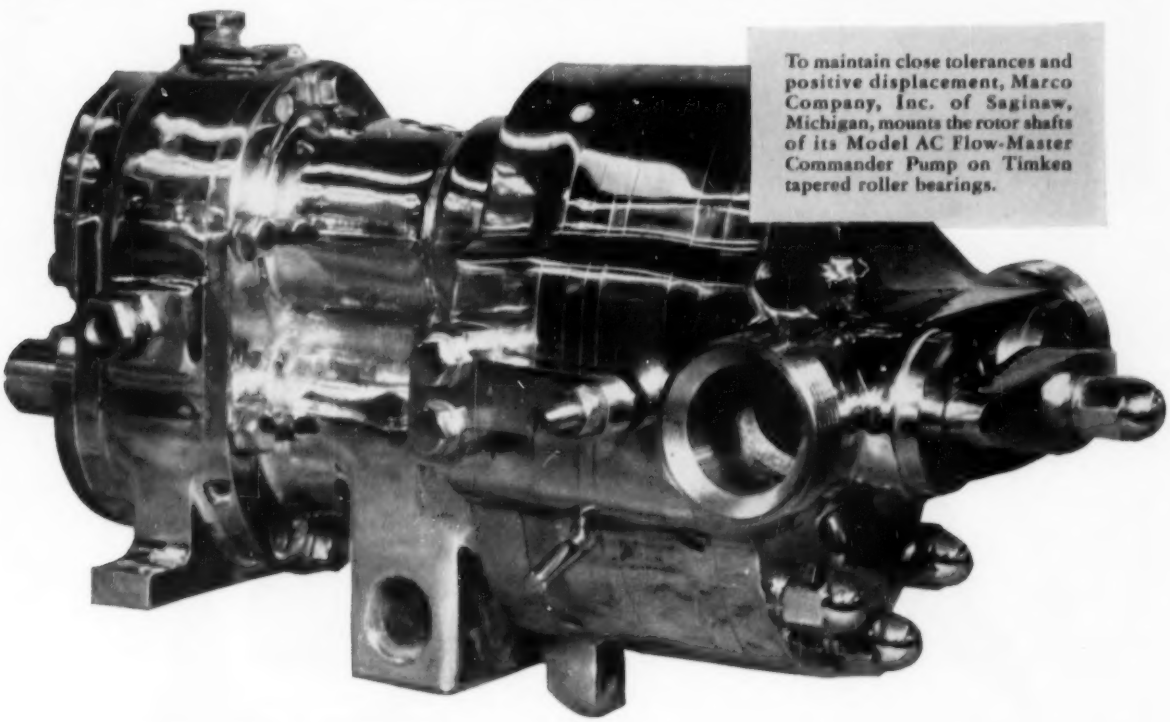
Timken bearings carry both radial and thrust loads in any combination due to their tapered design. Shaft and adjacent parts are held in proper alignment. Wear is minimized.

Timken bearings make closures more effective by holding shafts and housings concentric. Dirt and moisture are kept out—lubricants kept in. Lubrication time and costs are reduced.

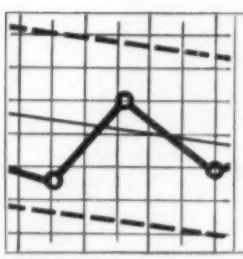
Full line contact between rollers and races gives Timken bearings extra load-carrying capacity. They are designed for true rolling motion and precision manufactured to live up to their design. And they are made of Timken fine alloy steel to assure quality in every bearing.

No other bearing can give you all the advantages of Timken bearings. Specify them in the machinery you build or buy. Look for the trademark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



To maintain close tolerances and positive displacement, Marco Company, Inc. of Saginaw, Michigan, mounts the rotor shafts of its Model AC Flow-Master Commander Pump on Timken tapered roller bearings.



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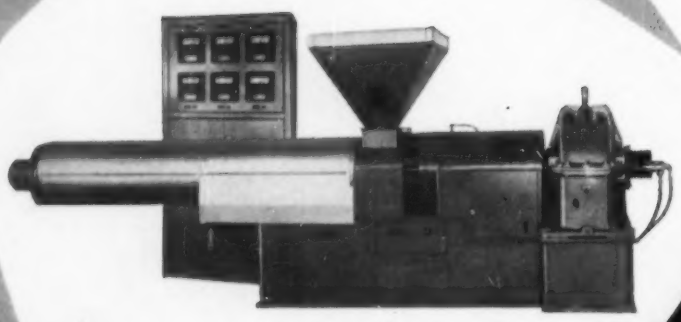

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- **Disperses with ease!**
- **Excellent electrical properties!**
- **Reduces volume cost!**
- **Repels water!**

Now it's here . . . in full production . . . a brand new lead complex. "Dutch Boy" Lectro "60".

Outstanding for water repellency. "Dutch Boy" Lectro "60" is insoluble and completely non-absorptive . . . actively repels water penetration. Prevents porosity. What's more, it demonstrates excellent volume resistivity over a wide range of temperatures. When TW and comparable vinyl insulations are stabilized with *Lectro "60"*, they pass immersion tests with flying colors.

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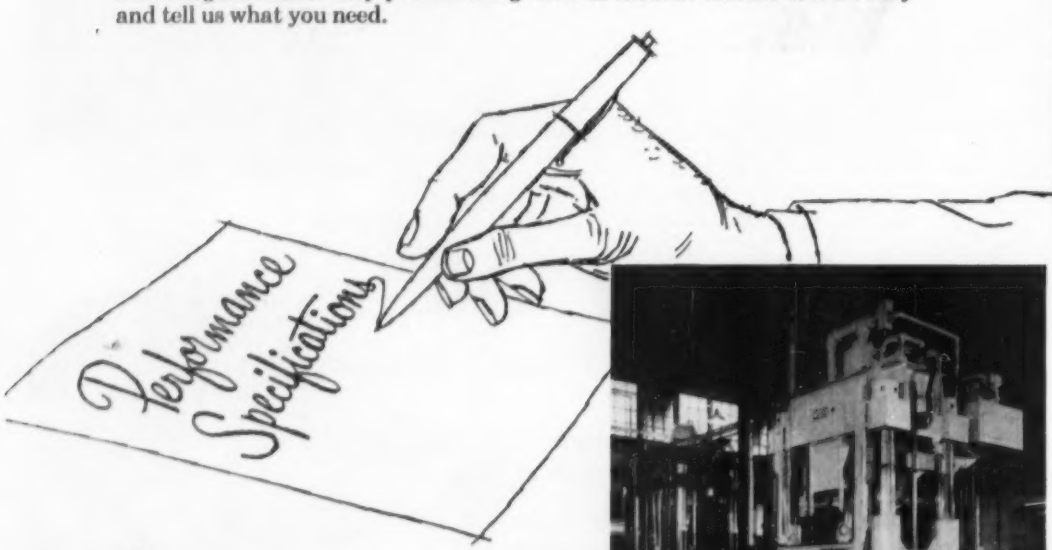
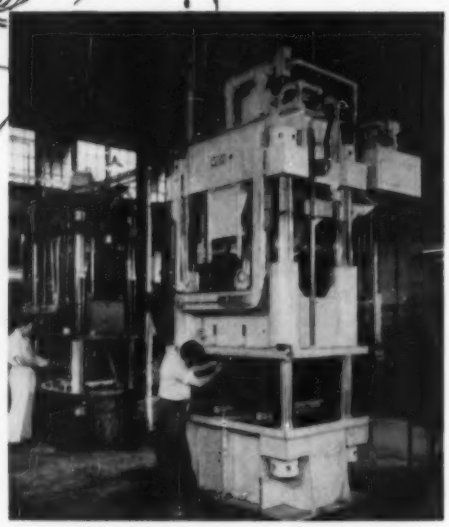
YOU WRITE THE TICKET...

WE WILL BUILD THE PRESS!

TELL US WHAT FEATURES you want in your next press for molding reinforced plastics—the advance and closing speeds, the heat and pressures needed, the other features that will improve quality, speed up production, and reduce costs. We will engineer a Dake Press to provide *exactly* what you need . . . just as we are doing for other molders.

Let Dake help you stay abreast of this fast-moving industry, with equipment engineered to keep production geared to modern trends. Write today and tell us what you need.





➡ Here are two of the three Dake Plastics Presses that were built successively over a 30-month period to meet the changing requirements for molding refrigerator parts. Newest is the press at right, which has numerous advanced design features that were not considered possible when the other two presses were built! This is an instance of how rapidly Dake Presses are engineered to keep pace with the needs of the plastics industry.

Dake Corporation, 648 Seventh St., Grand Haven, Mich.

DAKE PRESSES

Arbor Presses

Hand-Operated Hydraulic

Power-Operated Hydraulic

Guided Platen

Gap Type Presses

Movable Frame

Joseph Davis Plastics

ACETATE

Hi-impact Styrene

SHEETS
FILM

Rods and Tubes

Transparent, translucent, opaque . .

light-to-heavy gauges..cut and slit-to-size

suitable for **VACUUM FORMING**

Visual Tool container made of JODA clear ACETATE for U. S. Plastic Molding Corp. by **PHIL STILLPASS CO.** Long Island City, N. Y.

Cosmetic container made of JODA ivory ACETATE for COTY by **VE-ALITE PLASTIC CORP.** Brooklyn, N. Y.

JODA EXTRUDED CELLULOSE ACETATE SHEETS, ROLLS AND FILM declared to be best quality on the market . . . the result of a survey conducted by one of the largest chemical manufacturers in America.

Sales Representatives Conveniently Located

JOSEPH DAVIS PLASTICS COMPANY

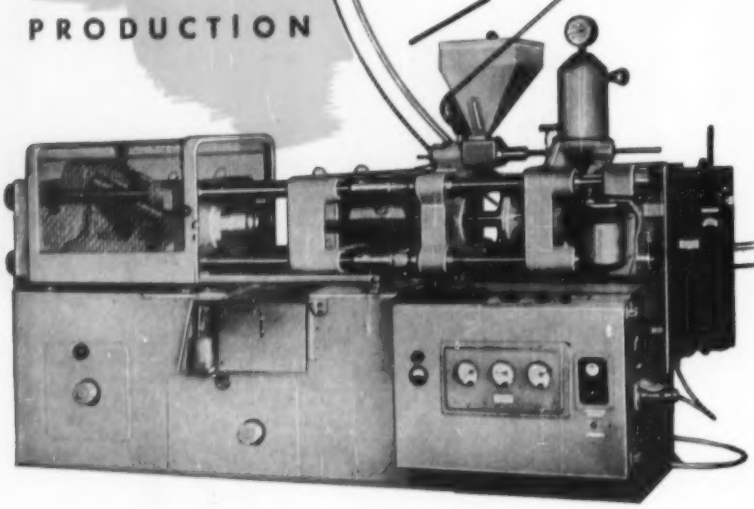
Phone KEarny 2-0980-0981 JODA N.Y. REctor 2-8354

Reg. U.S. Pat. Off.

430 Schuyler Ave., Arlington, N. J.

Time calls

FOR FULLY AUTOMATIC PRODUCTION



reliable, uniformity of cycle dictated by machine, labor and operating costs cut to lowest levels

therefore

BATTENFELD

FULLY AUTOMATIC INJECTION MOULDING MACHINES

1/2 to 50 ozs. capacity

BATTENFELD MASCHINENFABRIK **MEINERZHAGEN i. WESTF.**
Germany

14-ft. boat hull molded from Bigelow's FORMAT by Winner Manufacturing Company, Inc., Trenton, N. J., using pressure bag method.

BIGELOW
Fiber Glass Products

"Form-Fitting" Fiber Glass Mat Makes Better Boat Hulls Faster!

BIGELOW'S WIDE FORMAT* ELIMINATES MULTIPLE LAYERS AND LAMINATIONS, CUTS PATTERN COSTS

There are four important reasons why leading manufacturers of boat hulls select FORMAT:

1. **It *"form-fits"*** your mold because of its uniformity and drapeability . . . fills in curves and crevices . . . greatly reduces notching and slitting.
2. **It's the *widest*** glass mat in the industry . . . 84 inches! That makes it possible to lay down an entire hull in one longitudinal operation . . . eliminates tedious cross-width methods.
3. **It's the *heaviest*** fiber glass mat on the market . . . available up to 10-oz. per-sq.-ft. weight . . . more than three times the weight of other mats. This cuts time, labor and pattern costs by eliminating multiple layers!
4. **It's *mechanically bound* . . .** a FORMAT *exclusive* that gives you a mat uncontaminated by chemicals that might cause discoloration or blistering in processing!

*A Bigelow Trademark

BIGELOW Fiber Glass

can solve *your* Production Problems!

An engineering staff with an outstanding record of achievement is at your service. Let them show you how the complete line of Bigelow glass reinforcing materials can do a better job at lower cost for you!

Bigelow Fiber Glass Products

DIVISION OF

BIGELOW-SANFORD CARPET COMPANY, INC.

140 MADISON AVENUE, NEW YORK 16, NEW YORK

BIGELOW FIBER GLASS PRODUCTS
140 Madison Avenue, New York 16, New York

Please send complete information on Bigelow Fiber Glass Products.

☐ Glass Mats ☐ Woven Roving ☐ Glass Cloth

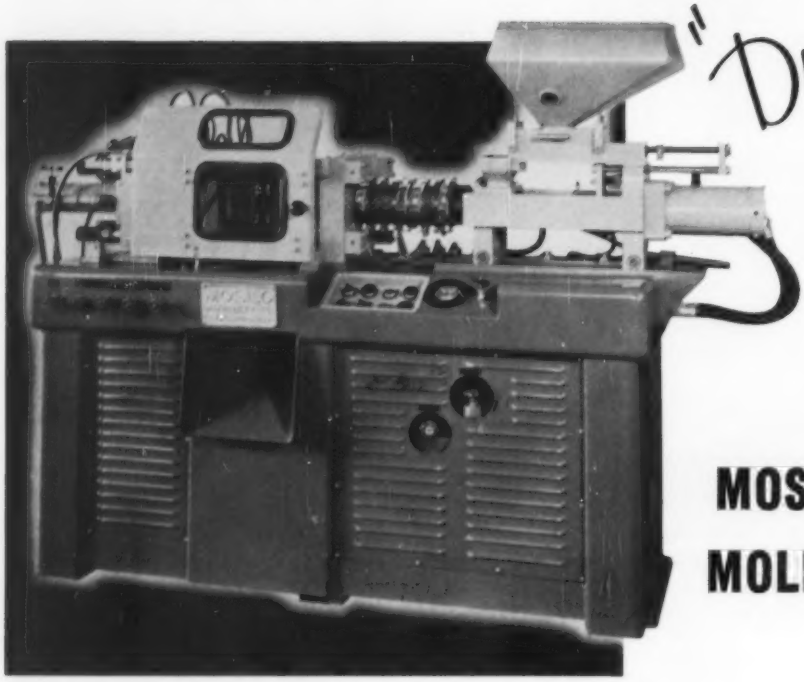
NAME .....

FIRM .....

ADDRESS .....

CITY ..... STATE .....

CONTAINER MOLDING IS "Duck Soup"



WITH A MOSLO INJECTION MOLDING MACHINE

The Moslo Model 74 Super 2-ounce injection molding machine is the last word for molding containers.

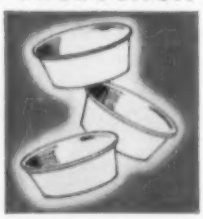
Especially designed and engineered to fit the needs of the container industry, this high-speed, fully-automatic machine will mold thin or heavy wall sections from a single or multiple cavity mold.

The best way to fully appreciate a Moslo machine is to come in for a demonstration. Bring your own molds and we will gladly show you the way to make container molding as easy as "Duck Soup".

COMPARE THIS FOR PRODUCTION

Illustrated at the right is a polystyrene dish produced on a Moslo Super 2-ounce machine. Seven hundred and twenty (720) of these 6-ounce dishes were shot per hour from a single cavity mold. Specifications are:

Wall thickness	.025"
Top diameter	4"
Bottom diameter	3.078"
Depth	1¼"
Weight	12.5 grams



The MOSLO line includes these models, ideally suited for container molding.

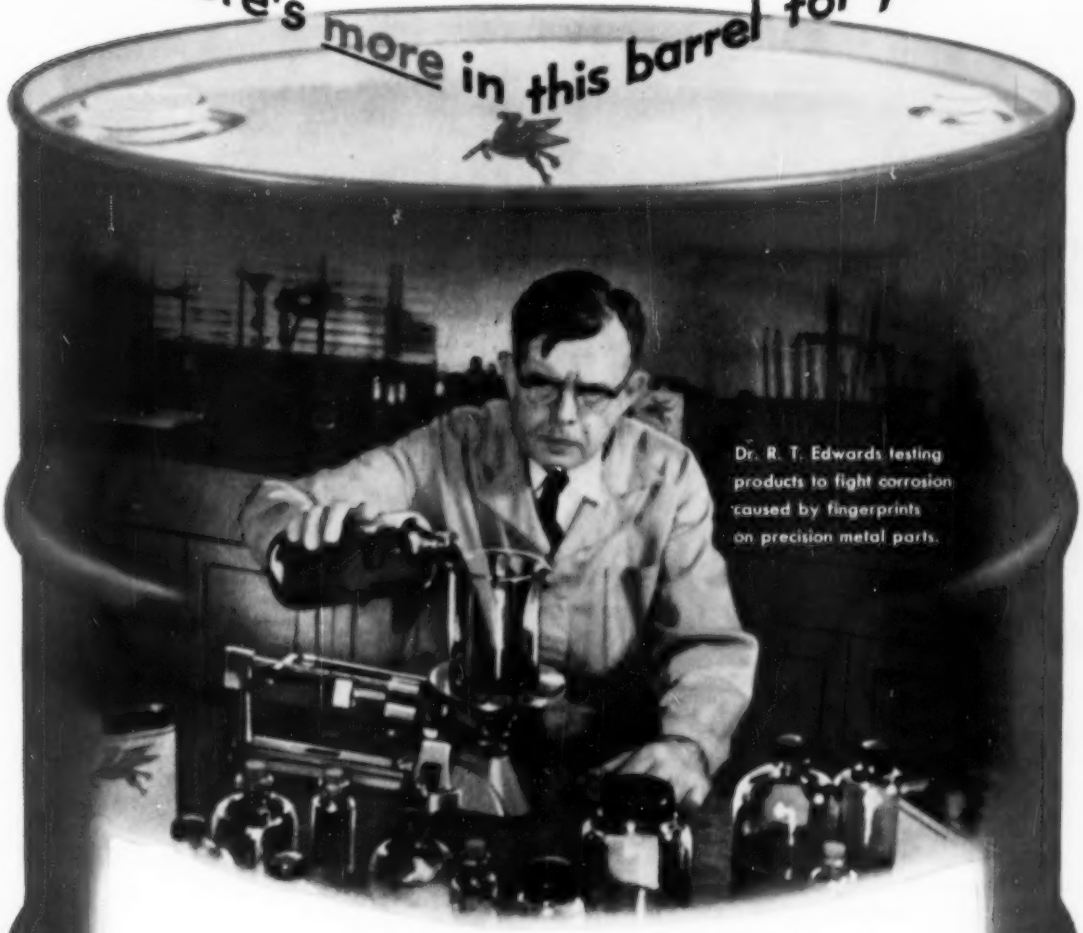
Model 74-7 –Super 2 ounce with 7" mold stroke
Model 74-12–Super 2 ounce with 12" mold stroke
Model 75-8 –High speed 3 ounce with 8" mold stroke
Model 75-15–High speed 3 ounce with 15" mold stroke
Model 76-8 –Super 3 ounce with 8" mold stroke
Model 76-15–Super 3 ounce with 15" mold stroke

FIGURE COSTS ON SINGLE CAVITY MOLDS – IT PAYS!

MOSLO MACHINERY COMPANY

2437 PROSPECT AVENUE • CLEVELAND 15, OHIO

There's more in this barrel for you...



Dr. R. T. Edwards testing products to fight corrosion caused by fingerprints on precision metal parts.

MORE CONTINUOUS RESEARCH

to help you improve production and cut costs!

When you specify "Socony Mobil," you get petroleum products backed by *more continuous research* than those of any other oil company! This means products which are *continually improved* in quality and performance—*new* products when needed. Equally important . . . these complete research facilities are available to *you*—to help improve your production and lower your unit costs.

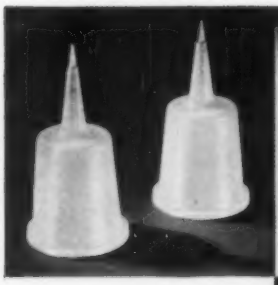
Socony Mobil products are also backed by *more* field engineers serving industry . . . *more* services for analyzing petroleum products in use . . . *more* on-the-job training of your personnel in correct product application . . . *more* approvals from machine builders . . . *more* practical experience—90 years!

Always specify Socony Mobil. There's *more* in every barrel for you!

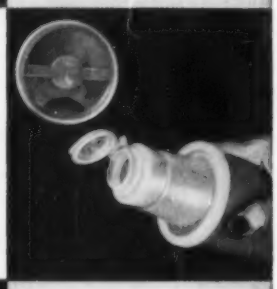
SPECIFY **SOCONY MOBIL** FIRST STEP IN CUTTING COSTS

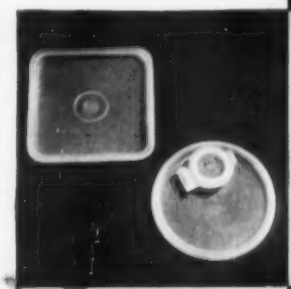
SOCONY MOBIL OIL CO., INC., and Affiliates: MAGNOLIA PETROLEUM COMPANY
GENERAL PETROLEUM CORPORATION

LUBRICANTS • FUELS • CUTTING FLUIDS • WAXES • SOLVENTS • PLASTICIZERS • PETROCHEMICALS



NOBODY HAS AS MUCH EXPERIENCE AT MOLDING POLYETHYLENE AS TUPPER!





Tupper Seals are air and liquid-tight flexible covers. The famous Pour All and Per Top covers are designed for easy dispensing. They are made in sizes to fit all Tupperware containers.

The logical molder for you to consult regarding that product or package of yours which is to be made of polyethylene is Tupper. Tupper has done more than any other molder to make molded polyethylene a practical reality.

Aside from having designed, patented, and promoted successful seals, closures, and dispensers for polyethylene containers, the Tupper Corporation has vast experience in *every phase* of polyethylene packaging and polyethylene injection molding. This experience will be of major importance in improving your product, in reducing your costs, when Tupper goes to work for you.

Tupper's combination of experience, technical ingenuity, and the most modern equipment is at your service for the custom molding of your product in polyethylene. You can do no better than the best ...and the best at molding polyethylene is Tupper!

When equipped with Tupper Seals, Tupper Canisters, Sauce Dishes, Wonder Bowls, Cereal Bowls and Funnels in various sizes are the most versatile reusable containers you have ever seen.

TUPPER!
TRADE MARK

TUPPER PRODUCTS ARE FULLY PROTECTED

About 150 United States and foreign patents and patents applied for, plus numerous trademarks and copyrights, cover the design and manufacture of the various types of Tupper Seals and other Tupper Products. Unauthorized manufacture of items covered by Tupper patents will subject infringers to prosecution.

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Manufacturers of — CONSUMER, INDUSTRIAL, PACKAGING AND SCIENTIFIC PRODUCTS

Factories, Laboratories and Sales Offices: Blackstone, Mass., Farnumsville, Mass., Woonsocket, R.I., Orlando, Fla., Montreal, P.Q. Showrooms: 225 Fifth Ave., N. Y. C.

Address All Communications To: Dept. M-2

NEW ENGINEERED FIBERGLAS MAT MEANS FEWER REJECTS—LOWER COST—HIGHER QUALITY

Industry's newest machine turns out laboratory quality mat in volume

Anderson, S. C.—The most completely automatic mat machine ever designed is now turning out miles of Fiberglas* reinforcing mat, "engineered to specification" in the Anderson plant of Owens-Corning Fiberglas Corporation.

The machine, incorporating entirely new features, holds closer tolerances in plastic reinforcement mat than ever before achieved.

Molders of reinforced plastics will welcome this new high in mat consistency. The new machine turns out consistent mat, allowing better control in the manufacture of your products. A number of new features make this possible.

Automatic Control Panel—one central station controls whole machine.

NEW FEATURES

Evenly-Wound Rolls—The roll-up unit on the machine produces even tension, non-telescoping, straight-edged, longer rolls—in a variety of widths up to *76 inches trimmed!*

Perfect Binder Cure—Multiple heat control zones permit a progressive binder cure as the mat travels through the oven. A perfectly cured mat is the result—neither under- nor over-cured for better molding and color control.

Four-Zone Oven—permits progressive binder cure.

Automatic Control Panel—One central station maintains machine balance for maximum uniformity. This panel, the only one of its kind, makes possible an engineered mat.

Controlled Manufacturing Conditions—The whole Anderson plant is completely air conditioned—for exacting humidity and temperature control. Even the binder resin is stored in a specially built Cold Room, to keep it at top quality.

NEW DEVELOPMENTS IN SIGHT

This new Fiberglas mat machine incorporates many improvements developed through a continuing research and testing program—the most comprehensive study of industry needs in reinforced plastics. This program will lead the way to even more significant developments.

• • •

Owens-Corning Fiberglas devotes a complete pilot plant operation to test ways to make better reinforcements, and to improve production techniques.

• • •

A new reinforced plastics testing program is under way. The information learned from analyzing finished products will be of great benefit to the entire industry.

Twelve new quality control techniques are being applied directly to that production in both Owens-Corning mat plants. Production engineering groups spend their full time studying ways to improve mat quality even further.

• • •

You can be sure that this research and testing program will have one effect—better reinforced plastics, and

Roll-Up Unit—produces evenly-wound rolls in widths up to 76 inches trimmed.

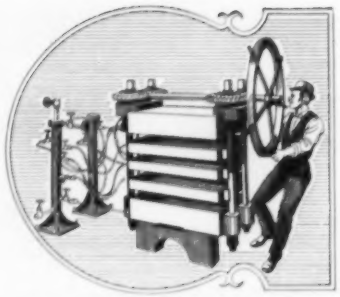
greater consumer acceptance for them. Owens-Corning Fiberglas will continue to lead the way.

OWENS-CORNING
FIBERGLAS
*T.M. Reg. O-CF Corp.

Owens-Corning Fiberglas Corporation, Textile Products Division, 598 Madison Avenue, New York 22, N. Y.

in the good old days

when Grandpa molded on this screw-operated press . . .



when one of the big names in the rubber industry was Goodrich-Tew & Company

ERIE FOUNDRY COMPANY WAS A GREAT NAME IN COMPRESSION PRESSES

in today's plastic shop

Fiberglass is molded on ERIE Presses that anticipate all possible requirements in reinforced plastics molding. This ERIE semi-automatic, self-contained press can be arranged with *three* closing and *two* opening speeds and tonnages. In a five-speed cycle, the ram meters down in high speed from the top of its stroke—stroke length is adjustable too—automatically moves into an intermediate speed and presses at low speed. Pressing speed and pressure apply when the material is contacted. After curing, the ram starts upward at low speed—adjustable from 0 to maximum—with high stripping tonnage applying to open the toughest mold. After die break-away the ram moves into high return speed. ERIE Press shown is down-acting. Up-acting rams are optional.

ERIE Fiberglass presses produce more perfect pieces per hour. Write for bulletin.

in our 60th year

ERIE

Today, the greatest name in specialized compression presses

ERIE FOUNDRY CO. ERIE, PA.

MUEHLSTEIN

REPROCESSED PLASTICS

Don't let the profit slip away. If you use Muehlstein Polystyrene, Polyethylene, Vinyl and other Thermoplastic materials, you're guaranteed important savings in material cost. You rake in more profits! If you have a special problem, our new laboratory assures you top quality control, efficient color matches—complete satisfaction. Call on us today and save.

NOTE: We offer top prices for distressed inventories of molded parts, purgings and all thermoplastic materials.

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REGIONAL OFFICES: Akron • Chicago • Boston • Los Angeles • Toronto • London
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Guarantee TOP Performance and Maximum Life!

Specify THESE TOP QUALITY FEATURES...

(Standard on Miller Cylinders at no extra cost)

Specify CASE HARDENED CHROME PLATED PISTON RODS
On all Air and Hydraulic Cylinders

Benefits To You

CASE-HARDENED Piston Rods (52-54 Rockwell "C") provide practically complete protection against damage from hammer blows, wrench-dropping, mishandling, and similar occurrences. ***Available from Miller at no extra cost.***

The HARD CHROME PLATING over the case-hardened rods protects against scratch-damage and rust. ***Available from Miller at no extra cost.***

Specify "TEFLON" WIPERS
On all Air and Hydraulic Cylinders

Benefits To You

"TEFLON" Rod Wipers and "TEFLON" Hydraulic Piston Rod Seals withstand temperatures from—100°F. to plus 500°F. They are impervious to practically all known chemicals, including the fire-resistant, special, and standard hydraulic fluids in current use. ***Available from Miller at no extra cost.***

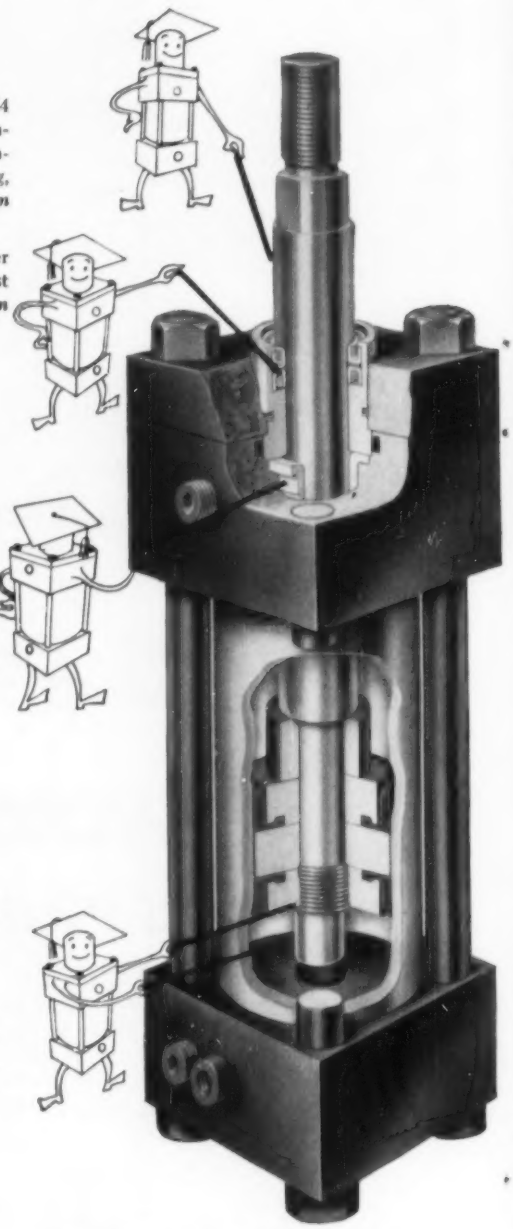
Specify TEFLON HYDRAULIC ROD SEALS
On all Hydraulic Cylinders

Specify RUST RESISTANT SURFACES
On all Air and Hydraulic Cylinders

Benefits To You

Highest quality Black Ferric Oxide Finish provides rust protection in air cylinder operation and on all cylinders during shipping and installation.

Cylinder heads, caps, mountings, pistons, followers, tie rods, and the unplated portions of the piston rods have this finish ***at no extra cost on all Miller cylinders.*** (This finish not recommended for water service)



You may wish to route this entire page to the proper department in your company, by using this handy form. Additional copies on request. →

To (Dept.) _____

"On all our future cylinder requirements, please specify the above quality features."

Signed _____

Title _____

See These New Features on Miller Cylinders at Miller

BOOTH #429

A. S. T. E. SHOW, March 19-23
International Amphitheatre, Chicago

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • TOLEDO • CINCINNATI • COLUMBUS
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MILLER FLUID POWER CO.

2020 N. Hawthorne Ave. Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

In 1945-46 You Benefited . . .

From the following quality cylinder "Firsts" offered by Miller Fluid Power Company on its standard catalogued power cylinders:

- ☐ 1. Square bar steel heads, caps, and components
- ☐ 2. Welded fabricated steel mountings
- ☐ 3. Detachable, interchangeable steel mountings
- ☐ 4. High tensile steel tie rods (4 per cylinder)
- ☐ 5. High tensile steel piston rods
- ☐ 6. Chrome Plated Piston rods
- ☐ 7. Wrench flats on piston rods
- ☐ 8. Non-corrosive tubing on large bore air cylinders
- ☐ 9. Step-cut piston rings on hydraulic cylinders
- ☐ 10. Dirt wipers on air cylinders
- ☐ 11. Dirt wipers and oil wipers on hydraulic cylinders
- ☐ 12. Non-adjustable, bubble-tight, leakproof piston rod seals on air cylinders
- ☐ 13. Non-adjustable, bubble-tight, leakproof piston seals on air cylinders
- ☐ 14. Non-adjustable, leakproof, hydraulic piston rod seals guaranteed not to leak even one drop of oil
- ☐ 15. Non-adjustable, leakproof, hydraulic piston seals guaranteed not to leak even one drop of oil
- ☐ 16. 98% plus operating efficiency on air cylinders of 4" and larger bores at 80 psi
- ☐ 17. 98% plus operating efficiency on hydraulic cylinders of 4" and larger bores at 130 psi
- ☐ 18. 1 psi no-load break loose pressure on air cylinders of 3¼" bore and larger
- ☐ 19. 3 psi no-load break-loose pressure on hydraulic cylinders of 4" bore and larger
- ☐ 20. Seal life in excess of several hundred million feet of piston rod travel on all of the above-mentioned piston seals
- ☐ 21. Precision-seal cylinders
- ☐ 22. Seals that seal with pressure on all hydraulic static seals
- ☐ 23. Catalogued line of hydraulic cylinders of 2000 to 3000 psi operating pressure

In 1954 You Benefited again —from Miller's . . .

- ☐ 24. Sizable stock cylinder program
- ☐ 25. Model 77 heavy duty detachable foot mountings

In 1955 You Benefited again —from Miller's . . .

- ☐ 26. Greatly expanded stock cylinder program
- ☐ 27. Case-hardened, chrome plated piston rods
- ☐ 28. "Teflon" hydraulic piston rod seals
- ☐ 29. "Teflon" dirt wipers on air cylinders
- ☐ 30. "Teflon" dirt and oil wipers on hydraulic cylinders
- ☐ 31. High quality rust preventive finish on all parts not otherwise protected from rust on both air and hydraulic cylinders

Enter in boxes above the YEAR in which your supplier first (if at all) gave you these benefits.

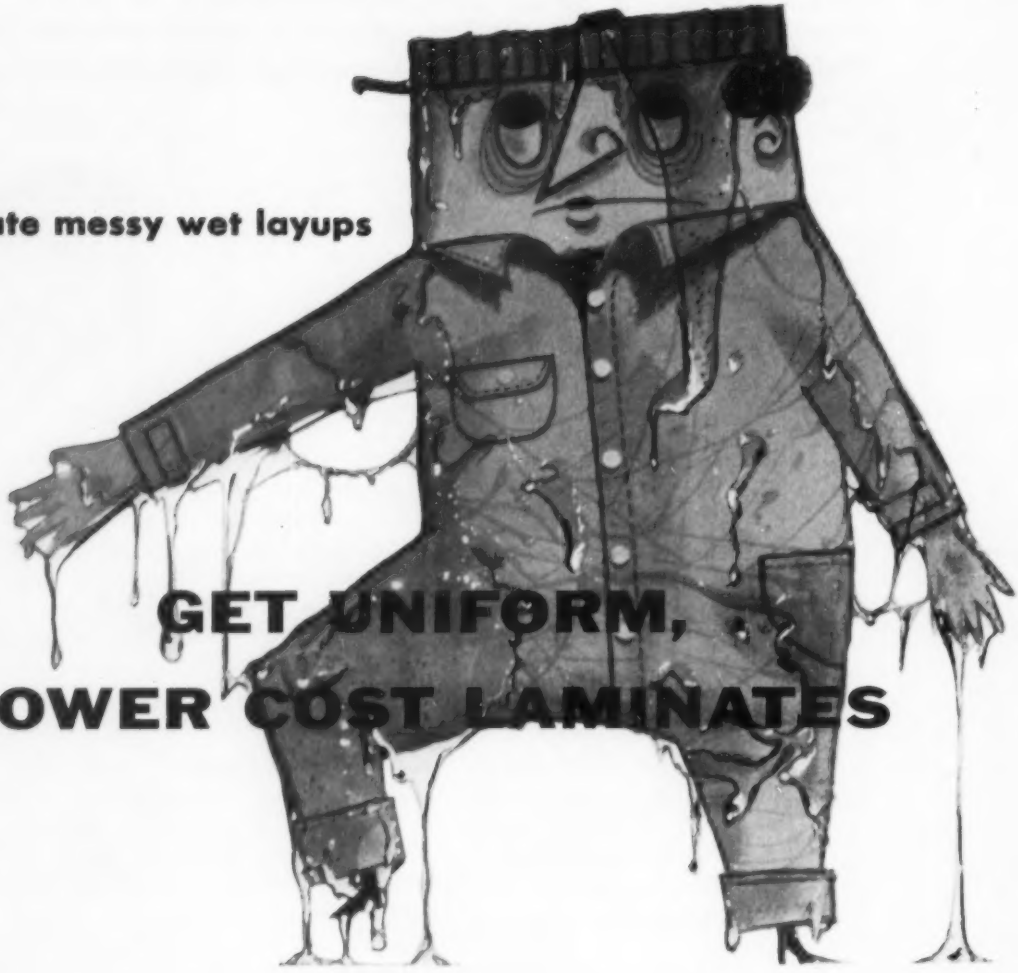
In 1956, You Will Benefit Again . . .

Miller

Watch For MORE Miller Firsts!

Miller

eliminate messy wet layups



GET UNIFORM, LOWER COST LAMINATES

Trevarno preimpregnated glass fabrics help you make better quality products, faster and more efficiently. Our exclusive "one company" operation performs weaving, finishing and impregnating under one roof, provides consistently uniform materials. It's this uniformity that assures proper drape, tack, flow, and resin and volatile contents layup after layup. Consequently, you can standardize your processing operations and cut costs.

A complete schedule of impregnations are offered in Phenolic, Epoxy and Silicone resin systems. Custom impregnations are available to meet your critical needs. Write today for product data and prices.

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COAST MANUFACTURING & SUPPLY CO.
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only **ONE** plant

offers you **ALL** *these*

SPECIAL PLASTICS SERVICES

to help you **REDUCE COSTS, SAVE LABOR**
SHORTEN PRODUCTION TIME, USE LESS MATERIALS

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- CELLULOSE ACETATE
- ETHYL CELLULOSE
- POLYSTYRENE
- BUTYRATE
- VINYLS
- ACRYLIC
- NYLONS

SERVICE
QUALITY
DEPENDABILITY

GER-PAK: Polyethylene Film, Tubing, Sheeting from .0005 to .100, also superior quality TS treated non-rub-off Printable Surface for display packaging.

GER-FLEX: Vinyl

GER-TUBE: Polyethylene Tubing from .060 to 4" I.D. Also special shapes, cross-sections, profiles, etc. Rigid and flexible formulations.

EXTRUDED ACRYLIC and HI-IMPACT SHEETS: Gauges .060 to .125; widths 54"; lengths 76"; continuous rolls. Clear and colors.

DRYCOL: Perfected in-plant on-the-spot colorant for all thermoplastics.

S-T-R-E-T-C-H: Polyethylene master-batch color concentrate.

STYRONEX: Clear polystyrene dry blended with color and lubricants, ready to mold.

PURGING COMPOUND: Eliminates need for disassembling injection molding cylinders. Cleans quickly, thoroly.

CUSTOM COMPOUNDING: Complete processing and laboratory facilities for long or short runs; special and standard formulations of all thermoplastics from virgin resins for injection and extrusion molding.

SCRAP-WASTE-REJECTS: Our experts will reprocess and rejuvenate, or we will purchase your accumulations.

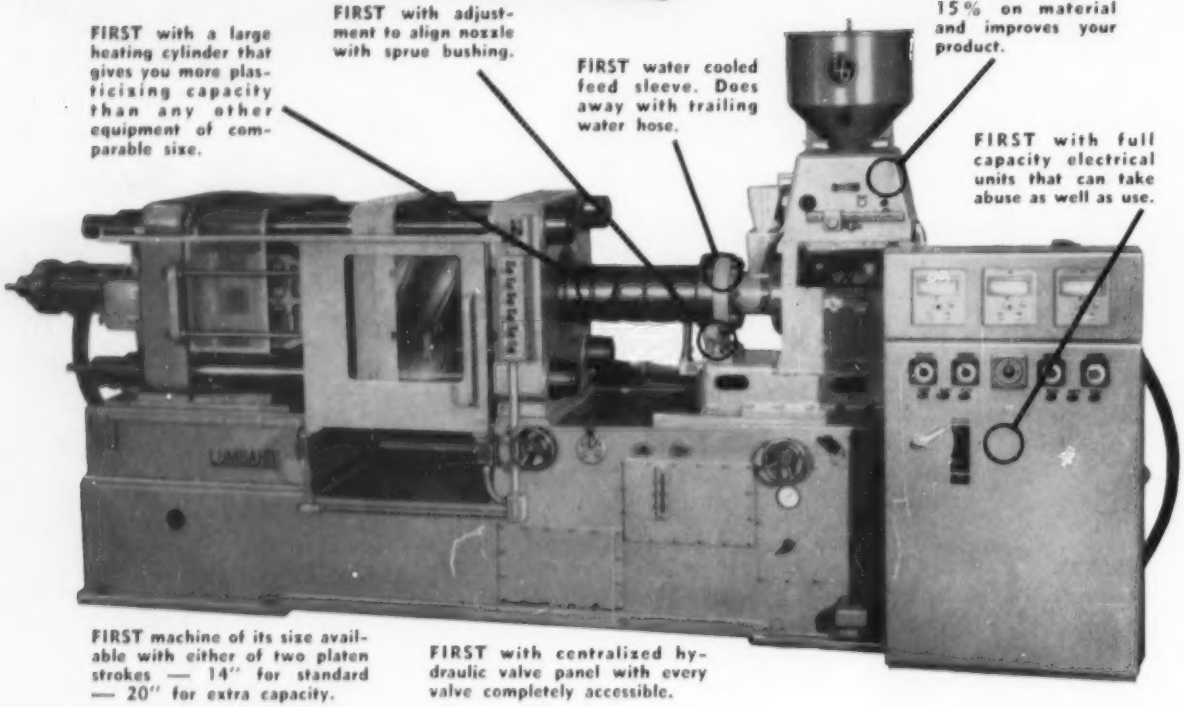
Who else but **GERING**!

"Pioneers in Modern Plastics for Over 30 Years"

GERING PRODUCTS, INC. Kenilworth, N. J.

BRANCH Offices: Chicago, Ill., Mansfield, Ohio; Cleveland, Ohio; Detroit, Mich.

Fastest Machine on the Market Today . . . the LOMBARD


FIRST with a large heating cylinder that gives you more plasticizing capacity than any other equipment of comparable size.
FIRST with adjustment to align nozzle with sprue bushing.
FIRST water cooled feed sleeve. Does away with trailing water hose.
FIRST machine of this size with a compensated weigh feed as standard equipment. Saves up to 15% on material and improves your product.
FIRST with full capacity electrical units that can take abuse as well as use.
FIRST machine of its size available with either of two platen strokes — 14" for standard — 20" for extra capacity.
FIRST with centralized hydraulic valve panel with every valve completely accessible.

We have built the better mouse trap and the path to our door is growing wider.

Customers have flatly stated that their Lombards produce as much in 8 hours as any of their other presses do in 12 hours.

Straight forward functional design by men with many years of experience in design, manufacture and operation of injection molding machines is the answer.

Larger die platens, longer mold opening, faster speeds, and greater plasticizing capacities will put you ahead in production capacity.

You'll need this increased capacity. It's available right now . . . with Lombard machines. Send for your copy of Lombard Brochure, Form 5, today.

LOMBARD GOVERNOR CORP.

Injection Molding Division

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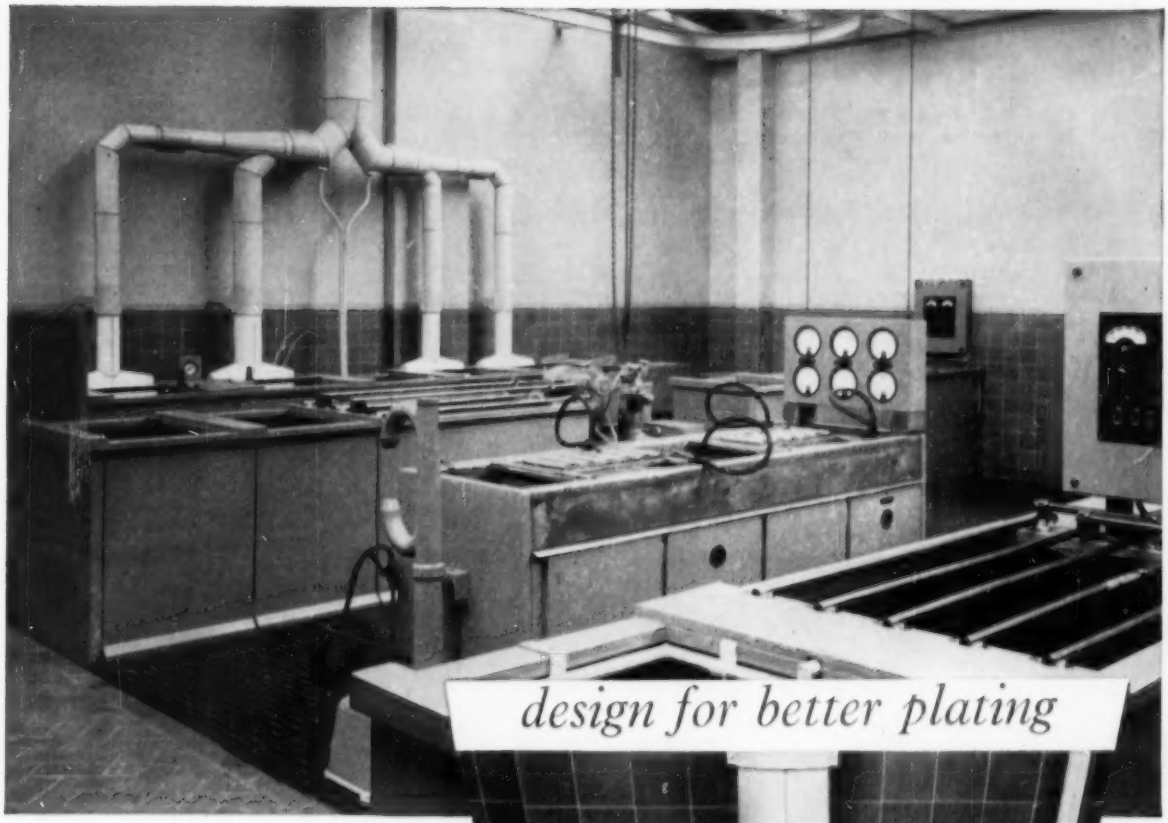

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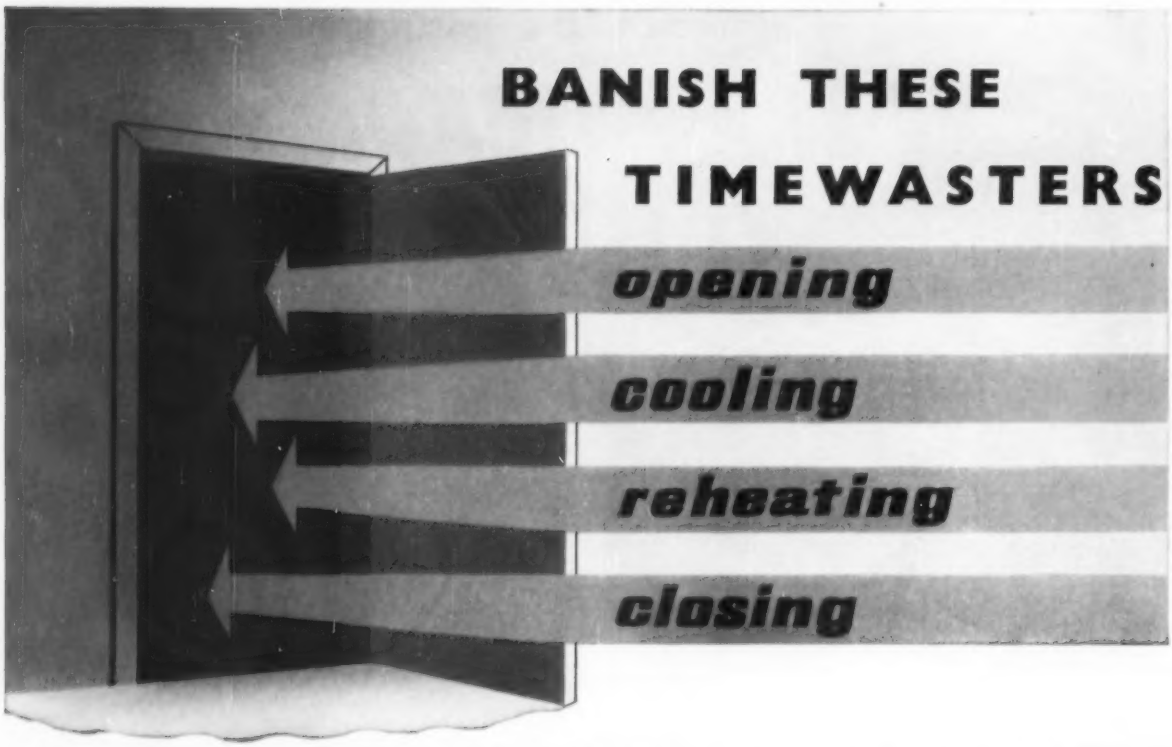

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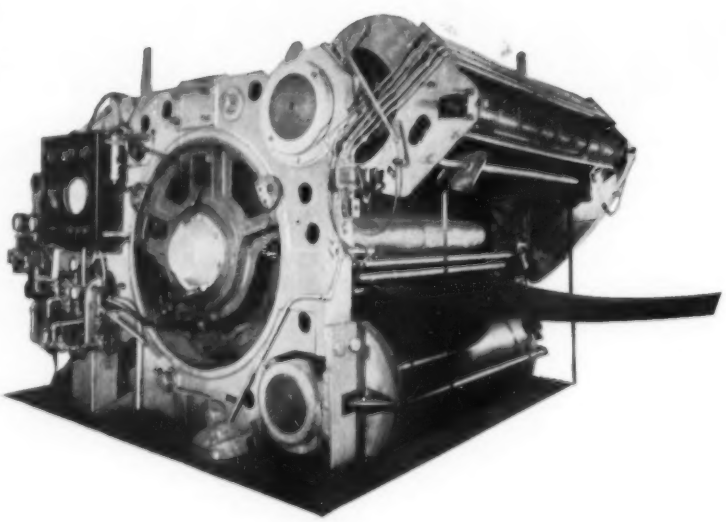

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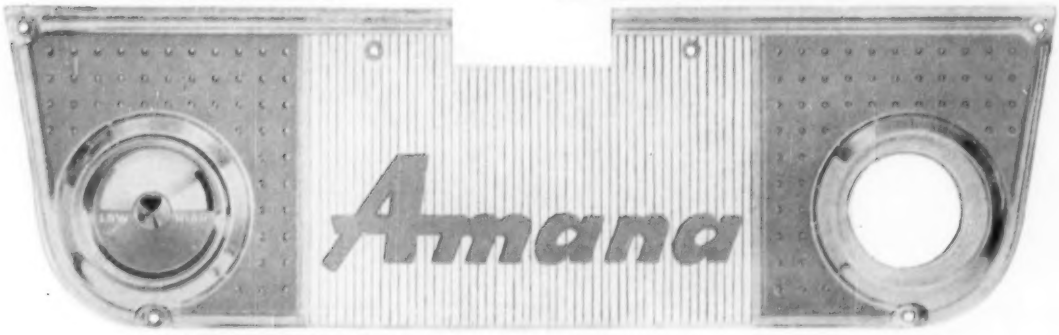

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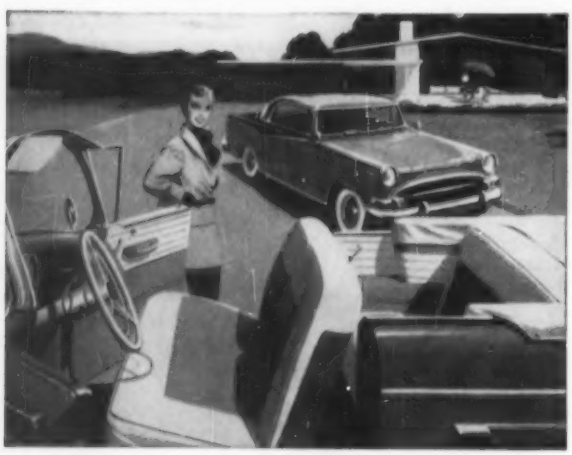

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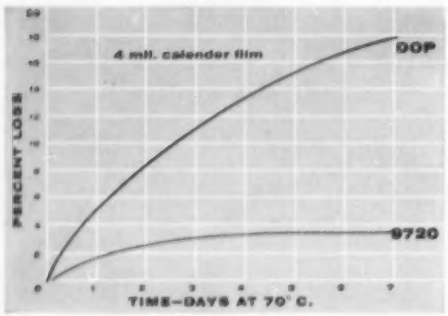
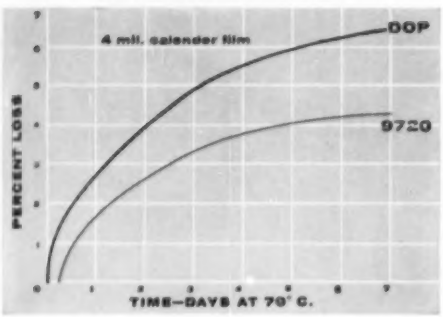


MINERAL OIL EXTRACTION



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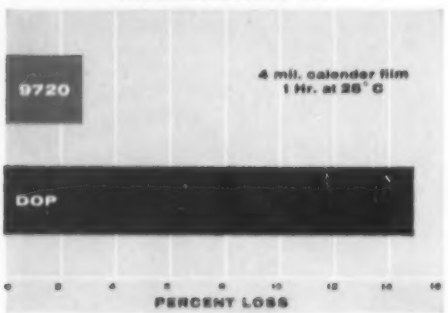

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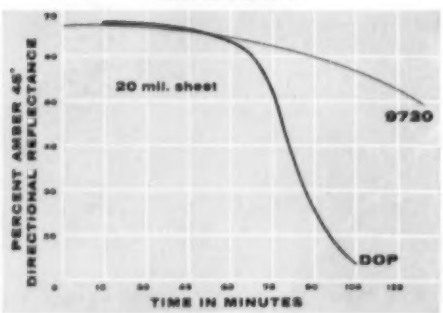

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MODERN PLASTICS
Volume 33
February 1956
Number 6

What's new in reinforcements

As the synthetic fibers invade the fields of laminates and molding compounds, the end user must evaluate new variables

Technological advances in materials for reinforcing plastics are being made at so rapid a pace that the production end of the industry—molders, laminators, fabricators—has still not had time to catch up with the research of the raw materials suppliers. Currently, about a dozen new materials, mainly synthetic fibers, and equally as many new forms of conventional reinforcements (including glass and paper) are being researched for a wide range of commercial applications; others are so new that no one has yet determined exactly where and in what way they can be used.

From all indications, however, the majority of new reinforcements can be expected to team up with conventional materials in significantly broadening over-all markets for plastics.

Answers to specific problems

Oddly enough, few of the reinforcements available today are competitive to any great extent. The properties which each offers differ sufficiently to prevent any serious overlapping of market areas. As the industry is now set up, each material seems to be finding its own level in specialized uses where its individual characteristics can provide the most practical and economical answer to specific engineering problems.

The goal in sight is the eventual acceptance of reinforcements as scientifically engineered materials capable of being combined with plastics resins to provide a specific range of properties for a given end product. Thus, research activity is being channeled in two directions. In part, this development work is being directed at expanding applications for the more conventional reinforcements (e.g., wood, kraft paper, rag paper, natural fibers, etc.) along the well-established lines already familiar to laminators and fabricators. (For a complete review of these old-line materials, see MODERN PLASTICS Encyclopedia Issue, Sept. 1955, p. 266.)

But by far the largest share of the research has centered around four types of reinforce-

Electrical parts are prime application outlet for glass-reinforced phenolic molding compound. (Photo, Owens-Corning Fiberglas Corp.)

ments: 1) glass, 2) synthetic fibers, 3) asbestos, and 4) sisal fibers. None of these reinforcements are new to the plastics industry, but all four have, in recent months, undergone considerable development work aimed at broadening their bases of application. It is the purpose of this survey to review these recent developments as they apply to basic end-uses—high-pressure laminates, low-pressure laminates, and reinforced molding compounds. Fillers for molding compounds (which differ from reinforcements in that they are designed to lower cost rather than to make any drastic changes in end properties) will not be discussed.

Woven and non-woven

The job of selecting a reinforcing material from the many available is a complex one. In addition to the essential nature of the reinforcement itself, there are other variables that must be taken into account—compatibility with the resin; the type of processing equipment available; and the form (woven, non-woven, roving, granular, etc.) of the reinforcing material.

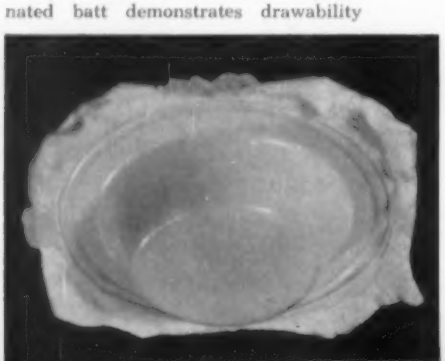
With the exception of two new types of glass materials (tiny flakes of film glass and unicellular spherulized particles), virtually all commercially available glass, synthetic, asbestos, and sisal reinforcements derive from fibrous materials. As such, there are so many ways that the fibers can be woven, twisted, bound, or chopped, that potential users are faced with a bewildering array of variations, each with its own specialized advantages.

For purposes of comparison, however, most of these variations fall under one of three basic categories: woven cloth, non-woven mat, or loose fibers. The construction of either of these three types starts with the individual fiber filaments supplied in the form of slivers (a number of fibers aligned in a continuous strand without twist), as rovings (a loose arrangement of a number of ends of sliver wound onto a core), or as yarns (fibers twisted together into a continuous strand suitable for weaving).

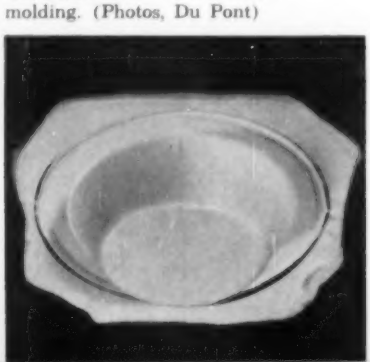
Woven cloth is higher in cost than non-woven materials, but imparts a higher degree of strength to the finished molding. Also, by vary-

Dacron reinforcement is supplied in batt form

Deep dish formed from unimpregnated batt demonstrates drawability



Impregnated dish after molding. (Photos, Du Pont)



ing the style of weave, the cloths can be made to fit a fairly wide range of diversified requirements.

Non-woven mats consist of short fibers laid down in a random pattern and bonded together by adhesive resinous binders or by mechanical stitching or "needling." Materials made in this manner have equal strength in all directions within the plane of the fabric. "Needled" mats are softer and more drapable than bonded mats, but the latter are stronger.

Of more recent vintage are the so-called "papers" being made from glass, synthetic, and asbestos fibers. In making a paper structure, fibers of a chosen papermaking length and chosen thickness are dispersed in water and distributed at random on the wire of a paper machine.

While the cloths and non-woven mats find prime application in laminating, the loose fibers sold in bulk form (consisting of strands chopped into short lengths) or as rovings that can be cut to size, are used in reinforced molding compounds and preform molding.

Slide viewer housing is molded of glass-reinforced styrene. (Photo, Owen-Corning)

Low-pressure laminates

As might be expected, by far the major share of research and experimentation has taken place in the field of low-pressure laminates and preform molding in matched metal dies—and much of it has been concerned not only with new and better ways of using glass, but with methods of adapting the unique qualities of non-glass fibrous materials to the scientific engineering of reinforced plastics products. Campaigns to promote the synthetic fibers (polyester, acrylic, acetate, nylon, and rayon) to the low-pressure field are already in high gear; even the inorganic fibers such as asbestos, long time favorite in the high-pressure field, are now making a strong bid for the low-pressure market.

It is highly unlikely that any of these newer reinforcements will supersede glass as a prime material in low-pressure laminates—particularly with so many improved versions of fibrous glass appearing on the market. While their unique qualities will certainly open new applications and expand established ones, one of

Properties of synthetic fiber reinforced laminates[1]

Properties	*Glass*	*Dacron*	*Orlon*	*Nylon*
Tensile strength, p.s.i.	23,400	10,800	7100	8200
Flexural modulus, p.s.i.	1,400,000	1,000,000	710,000	470,000
Impact resistance, notched Izod, ft.lb./in.	11.5	9.4	3.5	6.5
Compressive strength, p.s.i.	21,200	17,000	16,500	16,400
Dielectric constant @ 1000 cycles	4.5	3.3	3.5	3.8
Power loss factor @ 1000 cycles	0.0066	0.0051	0.0200	0.0239
Abrasion resistance,[2] mg. wt. loss	1400	200	300	150
Moisture absorption,[3] % H_2O Abs.	0.60	0.46	0.47	0.72

[1]Prepared by E. I. du Pont de Nemours & Co., Inc.

[2]Weight loss of laminates of 35% volume loadings based upon 1000 cycles on Taber Abraser.

[3]Percent water absorption in 24 hr. at room temperature in 35% volume loaded polyester laminates.

their biggest outlets will probably be in reinforcements in which they will be used in conjunction with glass.

High-pressure laminates

In contrast to the low-pressure field, high-pressure laminators are still not doing much talking about their research activities. Laminators and laminate customers are extremely wary about jumping too heavily into new fields of reinforcement. Part of this reluctance stems from the fact that each new type of reinforcement generally requires additional processing equipment, different methods of treatment, etc., and, as often as not, end results usually don't vary enough to warrant the expense. Most high-pressure laminators are already making use of an extensive range of materials, including at least 10 different kinds of papers, cotton, asbestos, glass, and in minor roles, some of the synthetics.

Cracking this line-up is going to be a major job for some of the newer reinforcements—but many of the laminators interviewed in preparing this survey feel that by the end of 1956, a good number of them will have made the grade.

Improved plastics resins for high-pressure laminating seems to have done much to stimulate interest in these newer materials. Many of these resins, e.g., epoxies, silicone, diallyl phthalate, etc., are formulated to afford resistance to high temperatures and to provide good electrical characteristics under adverse conditions. It stands to reason, then, that reinforcements must be chosen which can offer a similar range of properties in the same magnitude—and it is here that some of the newer materials with their specialized advantages fit in. To a large extent, a good deal of the development work along these lines has been aimed at the lush printed circuit market.

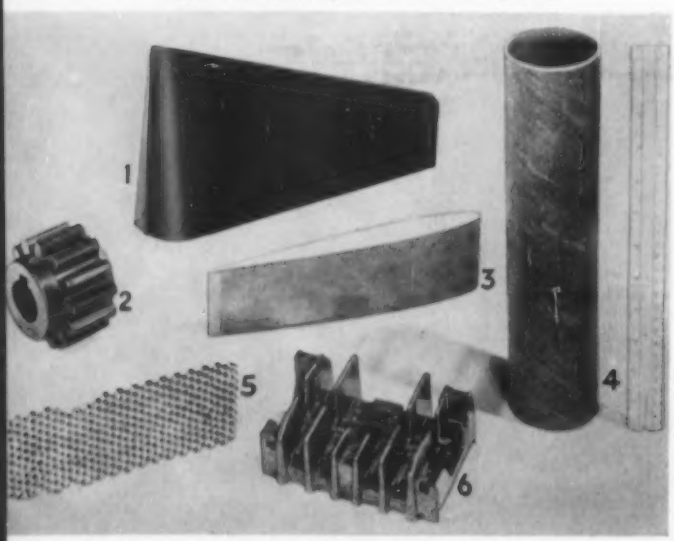
It is also in the field of electrical laminates that the "synthetic papers" are expected to find their major outlet. According to Hurlbut Paper Co., one of the paper manufacturers working with this new form, the company aim has been to create a new absorbent paper for laminates in which special features which cannot be met with cellulosic-type papers are desired such as better electrical characteristics, better heat resistance, better chemical resistance, lower moisture absorption, higher dimensional stability, and higher strength. The magnitude of these properties, however, varies considerably in degree among the many organic and inorganic fibers currently being investigated.

Reinforced molding compounds

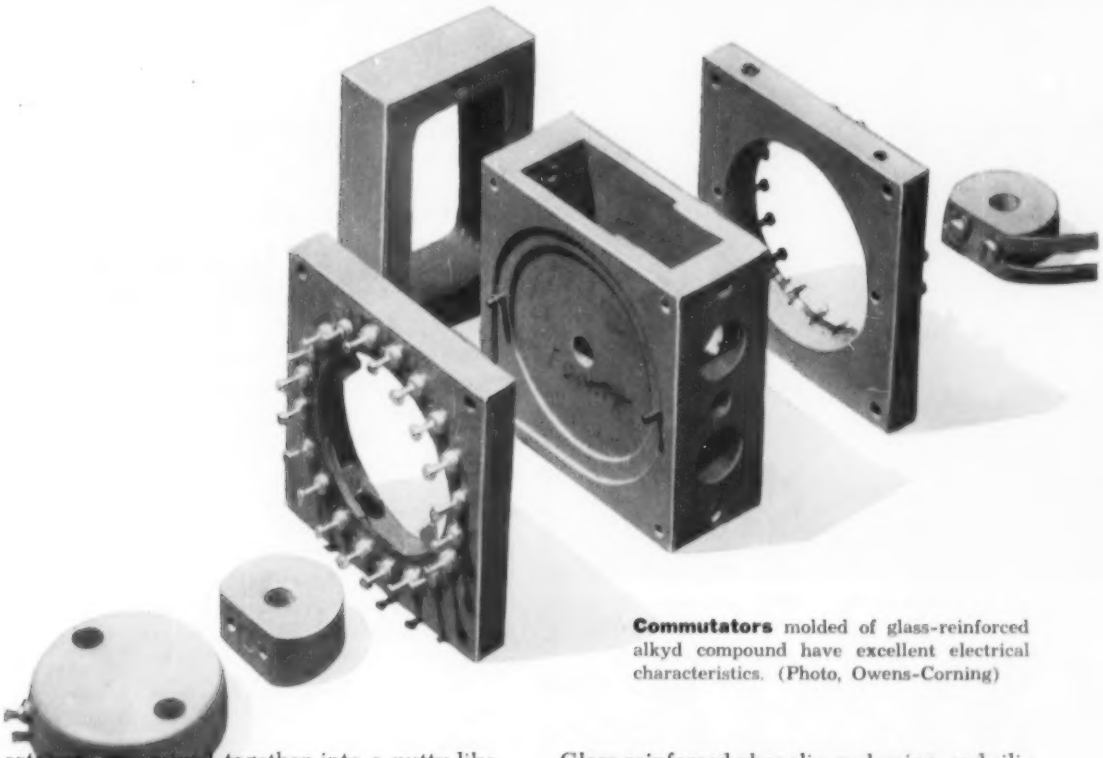
The concept of reinforcements for molding compounds is "old hat" to the plastics industry. For many years, a variety of organic and inorganic reinforcements, sometimes classified as fillers, have been in wide use, primarily for thermosetting compounds.

But in recent months there has been a considerable expansion in interest in the technique. Much of this derives from the large-volume use to which the automotive industry has been putting "premixes." Essentially, a "premix" is a combination of resin (generally a polyester), reinforcements (usually glass or sisal fibers),

Applications for asbestos-reinforced plastics include: 1) missile fin; 2) pinion gear; 3) airfoil section; 4) rocket launcher body tube; 5) honeycomb core; and 6) electrical switch gear. (Photo, Raybestos-Manhattan, Inc.)



Machining glass fabric-based laminate requires diamond saw. (Photo, Synthane)

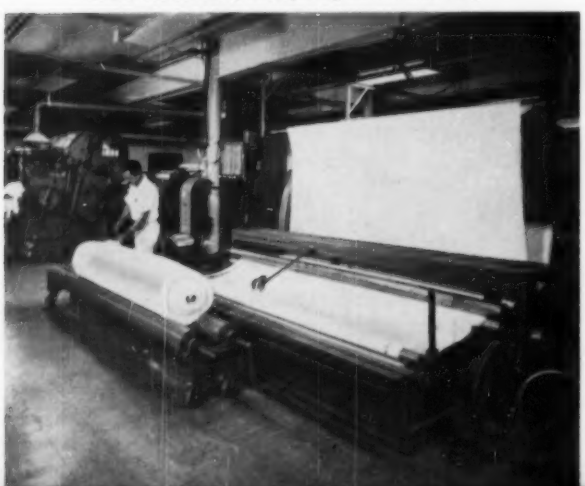


Commutators molded of glass-reinforced alkyd compound have excellent electrical characteristics. (Photo, Owens-Corning)

catalyst, etc., mixed together into a putty-like mass which can be molded in heated metal dies at relatively low pressures. Because of the difficulty of handling the "gunk" mixture, most molders have been compounding their own formulations, so that the making of a "premix" has remained largely a function of the individual molder.

More recently, however, several manufacturers have come out with easy-to-handle reinforced *molding compounds* which can be shipped around the country like conventional compounds and stored by molders until ready to use. Along these lines, one manufacturer is now compounding a fibrous glass-alkyd mixture into a rope-like form that can be wound on spools and cut to size by the molder.

Dacron fibers are made into uniform batts in needle loom. (Photo, Troy Blanket Mills)



Glass-reinforced phenolic, melamine, and silicone molding compounds are also being supplied to the industry. Even the thermoplastic molding compounds are developing into prime markets. Two companies supply a glass-reinforced styrene; another supplies a glass-reinforced ethyl cellulose molding compound; still a third is currently experimenting with a Dacron-reinforced styrene (which has improved weld-line properties) and an Orlon-reinforced acrylic.

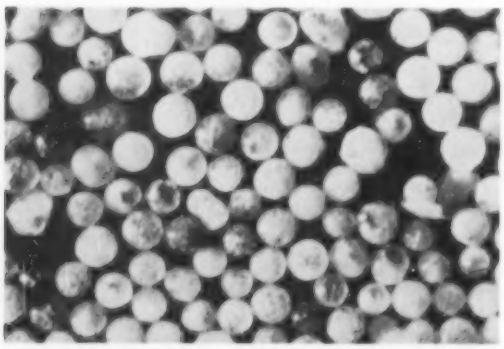
Fibrous glass reinforcements

Any discussion of reinforcing materials must include fibrous glass, since all other materials inevitably invite comparison with glass and since most of the producers of the synthetics and the inorganic fibers predict large-volume markets for their materials used in combination with glass.

As a reinforcing material, fibrous glass has much to recommend it for a wide variety of applications. Its tensile strength is higher than that of most other fibers; it has excellent flame and chemical resistance; it will not absorb moisture; it has good dimensional stability; and it has excellent electrical resistivity.

Reinforced plastics: In the low-pressure reinforced plastics field, two basic forms of fibrous glass are used: woven cloth and non-woven mat. Over the years, both forms have maintained essentially the same construction. What changes or refinements have been made have

New form of reinforcement consists of tiny flakes of film glass. (Photo, Owens-Corning)



Minute hollow glass balls can be used in encapsulation and tooling. (Photo, Ferro)

been towards improving over-all performance and meeting the requirements of individual jobs rather than towards opening new areas of application.

A mat recently introduced by Owens-Corning Fiberglas Corp., constructed of swirled continuous strands, rather than conventional chopped strands, for example, serves essentially the same purpose as the standard mat, but, because it draws deeper than standard mat and has a more decorative surface, it has economically moved in on the molding of many automotive body parts. It is the pattern of this swirled mat that serves as the background of p. 81.

Bigelow Fiber Glass Products, Div. Bigelow-Sanford Carpet Co., as another example, has retained the same essential mat construction as they always have, but have now devised a method of manufacturing the mat to any width up to 84 inches. A new technique has also been developed for pattern cutting mat to customer specifications with a minimum of waste, thereby reducing production costs for the fabricator.

In conventional woven cloths, development work is aimed at exceptional strength and uniformity, good surface, and ease of handling by fabricators. It has already been established by weavers that for highest strength qualities, an ideal construction would involve the arrangement of unidirectional filaments in parallel alignment.

Minnesota Mining and Mfg. Co.'s Scotchply is one step in this direction. More recently, there has been increasing emphasis on lower-cost cloths woven from fibrous glass rovings. Because of the unidirectional properties of the rovings, such cloth gives high strength to a laminate.

Both Hess Goldsmith & Co., Inc., and Bigelow, among other weavers, have worked along similar lines in developing weaves in which the warp is heavy woven rovings held together by very fine yarns which serve as the fillings.

And, recently, J. P. Stevens and Co., Inc., Fiber Glass Div., exclusive licensee and producer in the United States, introduced "Textiglass High-Modulus" glass fabrics designed to minimize the crimped yarn condition inherent in standard weaves. The new fabric is composed of two separate systems of yarns. The heavy yarn warps and fillings are aligned perfectly straight, one on top of the other. They do not crimp around each other at interlacings as do conventional weaves. Instead, light binding yarns (only 7% of the fabric by weight), interlace with each other to hold the structural yarns in place, but are so light that they have a minimum effect on the load carrying members. This construction, it is claimed, results in better strength characteristics, more rigidity, and better over-all properties.

Another variation similarly designed to meet the specialized requirements of specific jobs, is a knitted cloth marketed by Duofold, Inc., Mohawk, N. Y. Because of the knit construction (strands are interlooped, as opposed to woven cloth in which strands are interlaced at right angles), the cloth conforms well to irregular objects and is useful for the molding of radomes, tote boxes, seats for jet fighters, and helmets.

High-pressure laminates: Glass fabrics have been used in the high-pressure field for some time and, according to one supplier, this is still the larger market. With emphasis (*To page* 210)

Tripod turns to plastics

Sixteen plastics components made of five plastics materials give tripod added beauty, improve its operating efficiency

Utility and good looks are contributed to tripod by 16 plastics parts, four of which (camera pad, control stem grip, pawl release knob, and crank knob) are visible in photo

Given the problem of designing a camera tripod, what combination of materials will result, both function-wise and appearance-wise, in the best end-product?

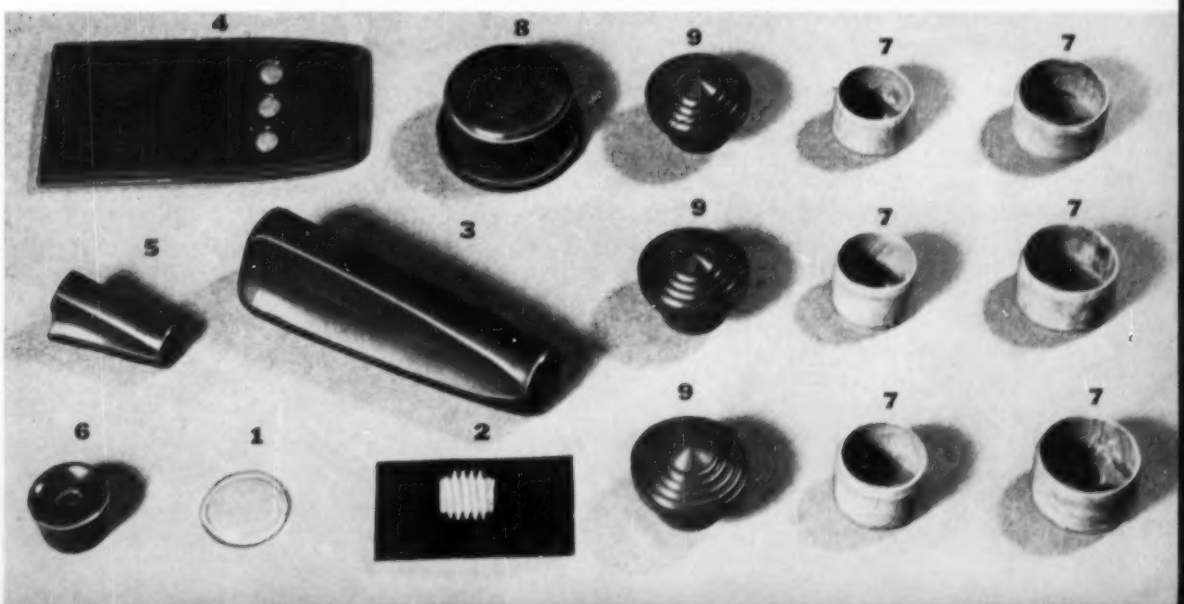
When Superpod, a universal elevating tripod for motion and still cameras was developed, this problem—basic to all industrial design—was exhaustively studied.

The result: Sixteen plastics parts made of five plastics materials (butyrate, nylon, general-purpose styrene, high-impact styrene, and elastomeric vinyl) are incorporated in each tripod assembly. The function of each of the plastic materials is discussed below:

Butyrate: The cover for the circular ball level mounted on the tripod head is heat formed of clear cellulose acetate butyrate. Because of its good flexibility, this convex butyrate window is easily assembled by simply snapping it in place on its flanged seat in the die-cast tripod head. Having high break resistance, it will not shatter during assembly or in use.

Nylon: The drive worm for (*To page* 227)

Plastics components incorporated in universal elevating tripod include (1) ball level crystal (clear butyrate); (2) drive worm for horizontal panning and panoram gear (nylon); (3) control stem grip, (4) camera pad, (5) crank knob, (6) pawl release knob (all high-impact styrene); (7) six clutch inserts for telescoping legs (general-purpose styrene); (8) elevating post bumper cap (injection molded elastomeric vinyl); and (9) three leg tips (injection molded elastomeric vinyl). (Photos, Felix Gilbert)



Toy sewing machine that really sews is

All plastic but the needle

Domestic sewing machines are complicated assemblies of many components, each of which must be fabricated or machined to very close tolerances. Because of this complexity, few engineers would even consider the job of designing the molds for an all-plastic toy replica of an existing commercial machine, especially if one of the requirements was that the toy had to be capable of actually sewing a straight seam.

Working model promotes real thing

Some three years ago, Hassenfeld Bros., Inc., started work on such a project because they visualized a stupendous market for a toy sewing machine, if it could be made sturdy and reliable. So well were the initial plans developed that, today, Hassenfeld has a toy item which is enjoying a sales volume that has already passed the one million mark and appears to have a potential limited only by the number of ambitious young seamstresses who want a sewing machine "just like mother's," even though it has no elecric motor and must be operated by hand.

Recently, Necchi-Elna, promotion-minded producers of domestic sewing machines, decided that if a working miniature of their latest model could be produced, they would certainly have hit upon an advertising approach that would have an unusual sales appeal.

The two companies got together. Hassenfeld had the edge because of their initial work and three years of experience with toy sewing machines; the mechanism was in production and the company was able to meet the Necchi-Elna requirements simply by designing a mold for a new housing that is an exact replica of the new "Supernova" being promoted by the sewing-machine manufacturer.

Fortuitously, the original Hassenfeld design was such that all the working parts of the toy machine could be assembled into the new housing. With the working toy (Fig. 1) available, the Necchi-Elna promotion scheme was put into high gear. The purpose was to get more people to come into retail stores for a demonstration and, to this end, the toy machine, which ordinarily retails at $2.95, was offered for $1.00, or almost two-thirds off retail, to every person asking for a demonstration of the "adult" machine.

Results exceed expectations

When interviewed regarding this new plastics application, Necchi president Leon Jolson stated, "Public response to the promotional use of the miniature Necchi Supernovas by our dealer organization has been truly amazing. As one example, Alex Glass of the Fort Worth Sewing Machine & Supply, Fort Worth, Texas, recently introduced the new Supernova to his

Fig. 2: Intricate components must be precision molded for trouble-free operation

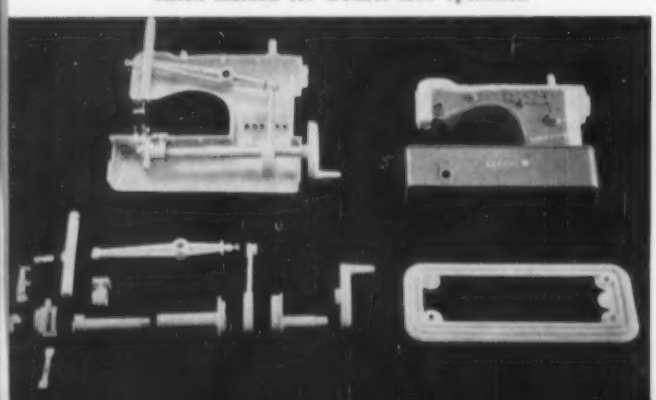


Fig. 3: Complete shot from a 35-cavity family mold used in making toy machine parts

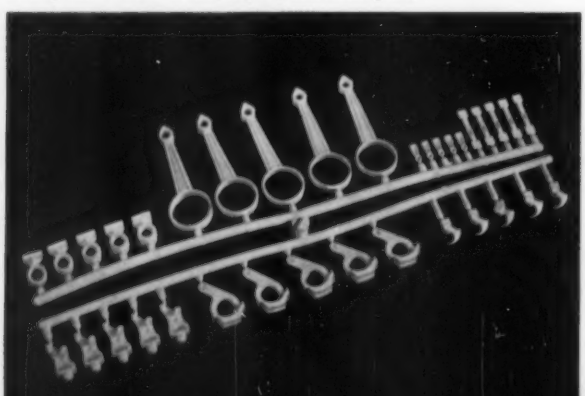


Fig. 1: Junior miss sews "just like mom" on successful promotional toy that is a styrene replica of a nationally advertised machine. (Photo, Necchi Sewing Machine Sales Corp.)

area with a promotional program built entirely around the miniature machine. He ran newspaper ads announcing a special 'open house' to be held at his store. All who attended could obtain the toy machine at a special price of $1.00. Results far exceeded Mr. Glass' expectations. So many people lined up waiting demonstrations that four policemen were required to direct traffic. At the end of the two-night open house, over 5000 visitors had registered and purchased the toy machine."

The clean lines of the exterior of this toy machine, as shown in Fig. 1, give no indication of the complexity of the assembly. But the exploded view (Fig. 2), which shows the 16 intricate parts, gives a good idea of the designers' problems; each of the components must mate perfectly with its neighbor. All of the working parts are injection molded of medium-impact styrene; general-purpose styrene is used for the housing.

Combination molds used

Four separate molds are used—three combination or family molds for the working parts and bases and one 2-cavity mold for the special Necchi housing halves.

One of the combination molds has 35 cavities. Each shot (Fig. 3) includes five inserts, five thread pullers, five bearings, five loopers, five feet, five foot guides, and five connecting rods.

Another mold (Fig. 4) has 20 cavities which

Fig. 4: Another family mold, this one with 20 cavities, produces these component parts

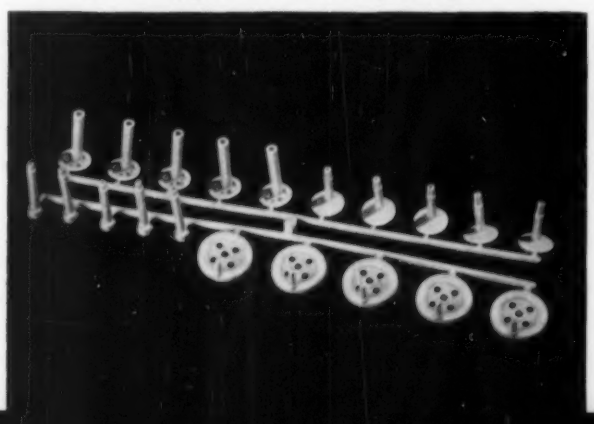


Fig. 5: Third combination mold is built with 12 cavities. (Photos, Hassenfeld Bros., Inc.)

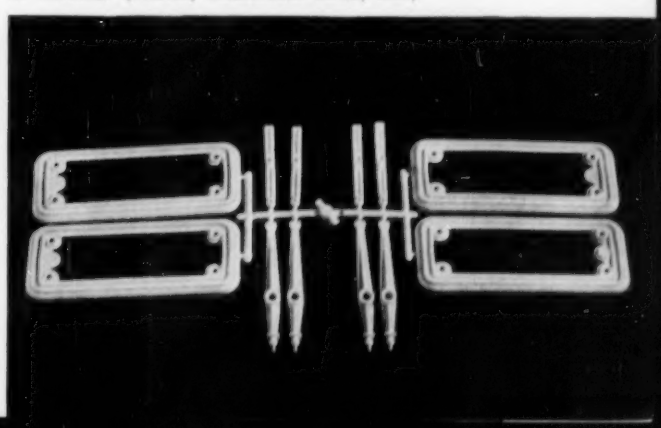


Fig. 6: Operator takes shot from two-cavity housing mold on 8-oz. machine

Fig. 7: First step in finishing operations consists of spray-painting the molded toy machine housings

produce, in each shot, five wheels, five cam shafts, five center shafts, and five end shafts.

The third combination mold has 12 cavities and each shot (Fig. 5) turns out four bases, four beams, and four pistons.

The combination molds are pin point gated and the parts produced in them need no finishing operations. Because these three molds are run at the comparatively slow speed of 32 sec. per cycle, the molder states that no trouble is experienced with warpage or other dimensional inaccuracies. The molds are designed so that they may be run either in 8-oz. Reed-Prentices or 8-oz. Lesters. Figure 6 shows the operator removing a shot from the 2-cavity housing mold mounted in an 8-oz. Reed-Prentice.

The total shot weights of the combination molds in the order given above are 64½ g., 110 g., and 95½ g., respectively; the housings weigh 94 grams.

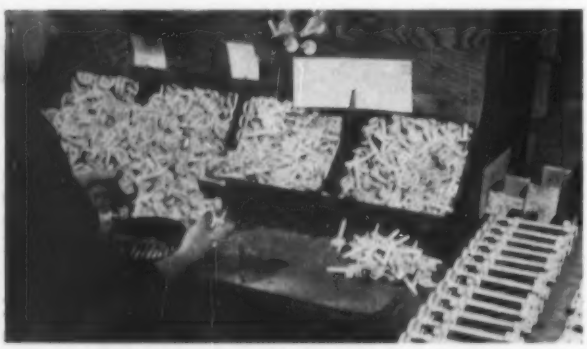


Fig. 10: Nine parts are combined into sub-assembly, using slip fit and gluing methods

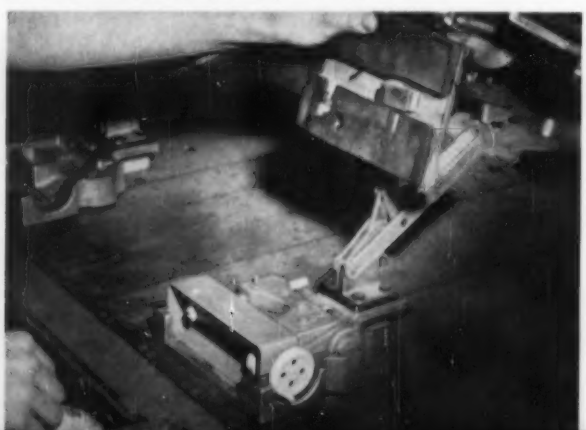
Assembly operations facilitated

As is to be expected, assembly of the 16 parts requires a great deal of hand labor, but specially designed jigs, fixtures, clamps, and spray masks help to reduce this labor to a minimum.

The housings are first sprayed (Fig. 7) and, after travelling under infra-red paint drying lamps, are delivered by conveyor belt to the next decorating station where the words "Necchi," and "Supernova," molded in raised letters, are overprinted with white paint by a

Fig. 11: Sub-assembly, piston, and beam are positioned in one half of machine housing

Fig. 12: Second housing half is solvent-cemented to first, using clamp to effect bond



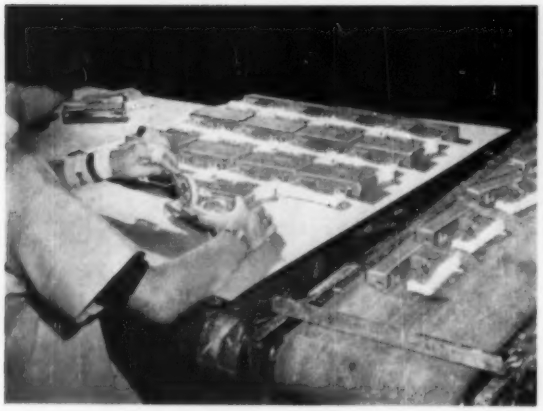


Fig. 8: Roller is used to overprint raised molded-in lettering with white paint

Fig. 9: Assembly of needle into piston proceeds on special holding and assembly jigs

roller (Fig. 8). A special holding jig and assembly fixture actuated by an air cylinder are used to assemble the needle—which is the only metal part that is used in the working assembly of the model—into the piston (Fig. 9).

Final assembly steps

In the sub-assembly shown in Fig. 10, nine parts are combined using a combination of slip fit and gluing methods. Final assembly consists of positioning the nine-part sub-assembly in one half of the housing and then properly locating and assembling the beam and piston (Fig. 11). The side edge of the other housing half is then softened by placing it on a felt pad wet with solvent, after which the assembly is clamped together until the two halves are permanently bonded (Fig. 12). A series of these gluing fixtures are carried in front of the assembly positions on a moving belt. Four rubber suction-cup feet are riveted on the bottoms (Fig. 13), after which the sewing machine is solvent assembled to its base (Fig. 14) and the entire assembly process is complete.

In order to be sure that each toy machine is in perfect working order, final inspection includes an actual sewing test (Fig. 15).

Credits: Materials: The Dow Chemical Co. and Monsanto Chemical Co.
Molds: Case mold—Leominster Tool Co., Inc.; all other molds—Alloid Tool & Die Co., Warwick, R. I.

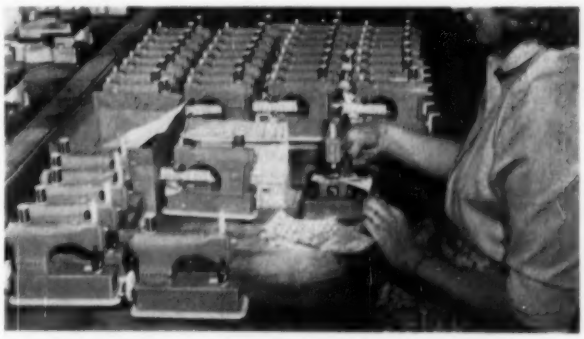


Fig. 15: Sewing test is part of final inspection of finished units. (Photos, Necchi)

Fig. 13: Four rubber suction-cup feet are riveted to machine base

Fig. 14: Final assembly step consists of solvent-cementing the housings of the machines to their bases

Close-up of extruded transparent acrylic wall

Plastic penthouse

Acrylic sheets, extruded with "tongue-and-groove" edges and assembled with nylon rivets, serve as walls of micro-wave relay station

Architects, builders, electronic engineers, sign manufacturers, plastics extruders, and others are showing more than ordinary interest in the acrylic penthouse structure perched atop the 14-story equipment building of the Southern New England Telephone Co. in New Haven, Conn.

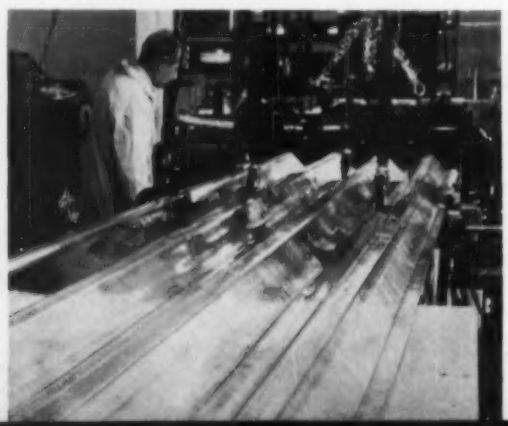
The structure, which houses a micro-wave relay station, is not only of unusual design and construction, but it also suggests numerous new application possibilities in residential and commercial construction for patio roofs and walls, carports, greenhouses, solariums, and similar buildings where transparency or translucency is desired; and it may hold the key to radio-wave distortion problems encountered in certain phases of the communications industry.

Why acrylic extrusions?

The penthouse measures 120 ft. long and 40 ft. wide. The plastic sidewalls consist of corrugated acrylic panels, 11 by 3 ft. in size and ⅛ in. thick, joined together to form the desired lengths of wall. The corrugations are 3 in. deep and 8 in. wide at the wide end, with a flat 1½-in. face at the narrow end of each flattened

Sheet emerging from extruder passes over special supports which prevent distortion

Conventional rolls below and narrow wheels above sheet help maintain tolerances



Interior view of micro-wave relay station; walls are of corrugated acrylic sheet (Photo, Rohm & Haas)

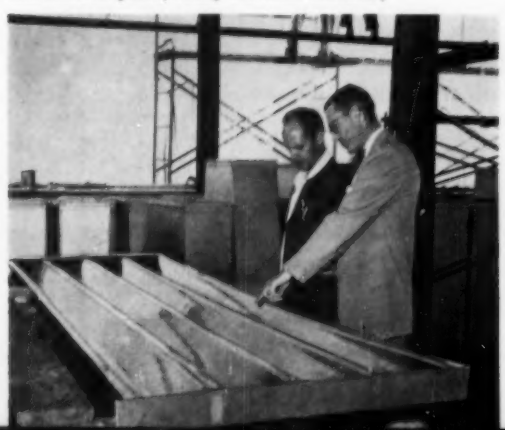
V-shaped corrugation. *And the panels are extruded!* They are, in fact, the largest corrugated acrylic extrusions that have ever been produced commercially.

The decision to use wall sections of extruded acrylic sheet was based on the unusual requirements of micro-wave equipment and experience with cast acrylic sheet, previously used for this same purpose.

To function successfully, the wall material for a micro-wave relay enclosure has to be free of metallic content (otherwise the micro-wave signal would be distorted); strong enough to withstand high-velocity gales; leakproof; and transparent.

In the case of the New Haven structure these requirements ruled out glass and glass-filled plastics, since glass has a metallic content, and concentrated attention on acrylic, which is free of metal and transparent. Acrylic can, of course, be cast in the size required and formed into a corrugated shape for adequate strength. But, experience indicated that wind-driven water seeped through cemented joints used to connect the sheets. If a "tongue-and-groove" joint could be used, it would provide an effective

Prefabricated acrylic panel, with end cap and shoe in place, ready for final assembly



Cork-neoprene sealing strip between sheet and shoe absorbs shock. (Photos, Sheffield)

barrier to water by acting as a capillary break; but such a joint could be produced under practical commercial conditions only by extrusion. And thus the decision to use extruded acrylic corrugated sheet was reached—and numerous technical problems were raised. These problems were solved through the cooperative efforts of the materials supplier, the company extruding the sheet, and the installation firm, all of whom pooled their talents to successfully complete the project.

Extruding the corrugated sheet

The volume of material to be extruded to meet the requirements was so great that special techniques had to be used to assure satisfactory results; critical controls were required over die temperature, extrusion speed, forced air cooling, and forming wedges.

The acrylic material was predried before extruding, by holding the material at 175° F. for 8 hours. These conditions were determined by checking test extrusions for moisture content.

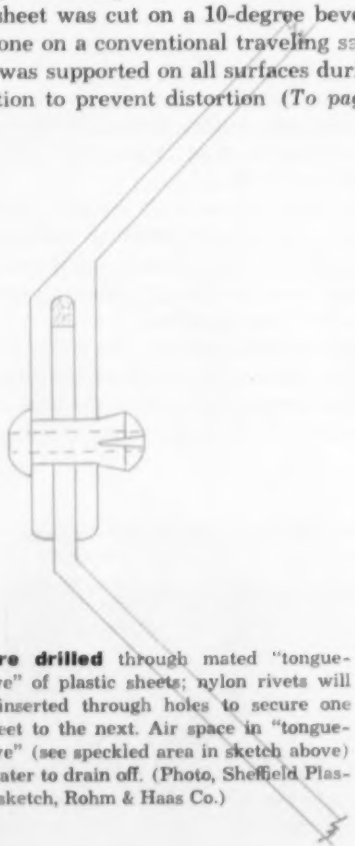
Die design: The extrusion die was designed along conventional sheeting die lines. However, because of the depth of the corrugations and the necessity for sharp corners, contouring of the shape took place in the die rather than in contouring members downstream from the extruder.

Constant flow and even gage were maintained by differential temperature control of both the body and face of the die. Multiple-point recording temperature controls were used to maintain as small a variation as possible with respect to time.

Cooling forms: Conventional supporting members were used downstream from the extruder so that contours and dimensional tolerances would be maintained until the plastic material cooled to a rigid state. These supporting members were positioned quite close to the die in order to avoid excessive drape of the hot extrusion. A magnetic thickness gage was used to determine and control the thickness of the sheet as it emerged from the die.

Take-off equipment: Conventional rolls were used under the sheet. However, narrow rubber wheels were used on top of the sheets. Their width was such that pressure was exerted only on the flat areas at the narrow ends of the corrugations where the undersides were in contact with the bottom rolls. This set-up minimized the danger of distortion of the corrugation.

Finish-sawing: To simplify subsequent assembly and to improve water-runoff, one end of each sheet was cut on a 10-degree bevel. This was done on a conventional traveling saw. The sheet was supported on all surfaces during this operation to prevent distortion (*To page* 229)



Holes are drilled through mated "tongue-and-groove" of plastic sheets; nylon rivets will later be inserted through holes to secure one plastic sheet to the next. Air space in "tongue-and-groove" (see speckled area in sketch above) permits water to drain off. (Photo, Sheffield Plastics, Inc.; sketch, Rohm & Haas Co.)

Happy youngsters out for a thrill-packed yet safe ride aboard reinforced plastics sleds. (Photo, G-E)

Operator punches holes for attaching hand straps and grommets for pull rope to sled. (Photo, Kalamazoo Sled)

Reinforced plastics in the 'Flying Disc'

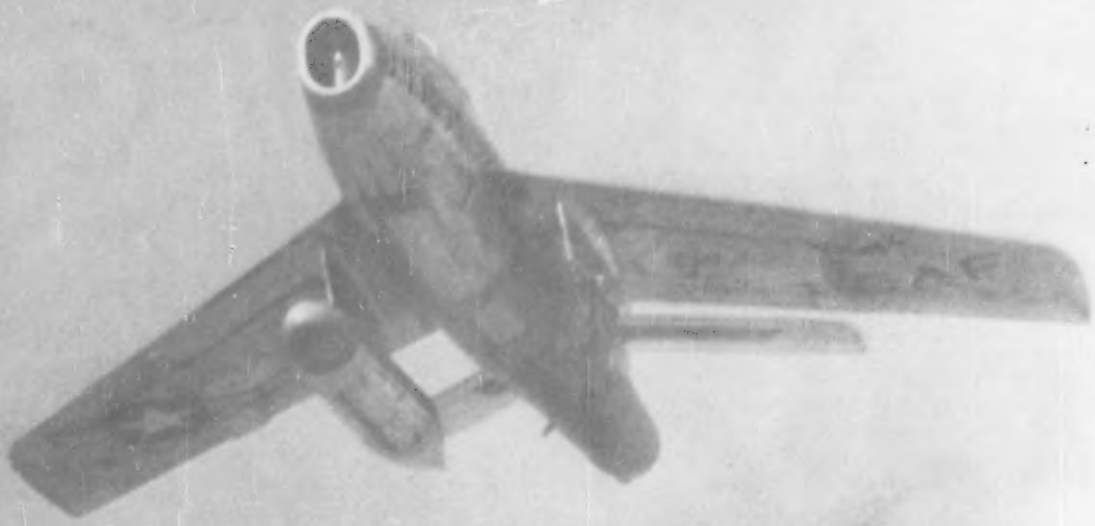
Grandma's dishpan used to be pressed into service for coasting down snowy hillsides. For small children it offered thrills not obtainable with standard sleds or toboggans. A ride on a dishpan was full of surprises. Indeed, it was frequently not too safe.

Kalamazoo Sled Co., Kalamazoo, Mich., taking a scientific approach to the relationship between safety and surprises in sliding, is now in quantity production of a saucer-shaped, lightweight sled molded of fibrous glass-reinforced polyesters. The "Flying Disc" has no sharp edges, has two sturdy webbing handles that are easily gripped by small mittened hands, is practically unbreakable and undentable, and slides smoothly over snow and ice.

Probably the lucky youngsters to whom Santa Claus donated "Flying Discs" did not realize that the product and the process whereby it is made was one of the results of the Arctic Sled Program developed by the Quartermaster Corps of the United States Army. The molder of the sled for Kalamazoo is Camfield Fiberglass Plastics Co., formerly of Grand Haven and now of Zeeland, Mich.; this same molder produced thousands of military arctic sleds (see MODERN PLASTICS Magazine, April 1952, p. 115), on which Kalamazoo Sled Co. did the final assembly work.

As with the military sled, the development of the "Flying Disc" was the result of two years of research. The proper size, for example, took some time to determine. The choice of material which would have a low coefficient of friction occasioned some study. Whether to mold a wire ring into the edge of the disc to reinforce the section or whether to use the turned down lip design—finally approved—was a matter of field testing, and the juvenile "test pilots" enjoyed themselves thoroughly.

Early in 1955 when design was finalized, one mold was ordered and prototypes (*To page* 232)



No aid to an enemy

Droppable jet-plane fuel tanks, made of reinforced plastics components, have military and economic advantages

Droppable plastic fuel tanks for jet aircraft are now in volume production by Molded Products Div., Admiral Corp., in its new plant at West Chicago, Ill. Having a standard length of 15 ft., a capacity of 225 gal., and weighing 115 lb., the tanks are fabricated of molded polyester-fibrous glass laminate sections, assembled by means of epoxy-type adhesive.

These tanks, being made for the U. S. Air Force under a combination research-development and production contract, are believed to be the first plastic auxiliary fuel tanks for military aircraft to be turned out on a mass production basis. Molded Products has now made more than 8000 of the units and is producing and shipping the tanks at a rate of approximately 50 per day. Prior to production of the tanks, the company had been engaged in research and development work on reinforced plastics tanks of this type.

Replaces aluminum

Development of the reinforced plastics wing tanks was undertaken by the U. S. Air Force. The decision to experiment with expendable plastic fuel tanks was based upon two major factors: aluminum, from which most droppable tanks are made, becomes extremely scarce in time of war; aluminum from dropped tanks can be salvaged and re-used by the enemy.

Up to the present time, all of the plastic tanks produced by Molded Products have been of the standard 225-gal. capacity. However, should a requirement ever exist, the tools for the tank sections are so designed that by adding or removing segments of the center section dies, tanks of 200- or 250-gal. capacity may also be made from the same basic set of molds. The tanks are composed of three principal components: nose, tail, and center sections. Identical nose and tail pieces would be used on all three sizes of tanks.

In addition to their relatively light weight and sturdiness, the reinforced plastics auxiliary fuel tanks also resist the deteriorating influences of most corrosive chemicals and weathering. Although at this point the plastic tanks are slightly heavier and somewhat more costly than their metal counterparts, it is believed that with engineering changes, the

Reinforced plastics fuel tank, jettisoned from F-84 jet, cannot be salvaged by enemy

weight and cost could be reduced to a point whereby these factors would be comparable. In addition, the fibrous glass-polyester tanks are of particular interest to our military authorities because they fracture when dropped and cannot be repaired for further use by an enemy. Exhaustive flight testing has proved their capability of meeting all conditions encountered in regular combat operations.

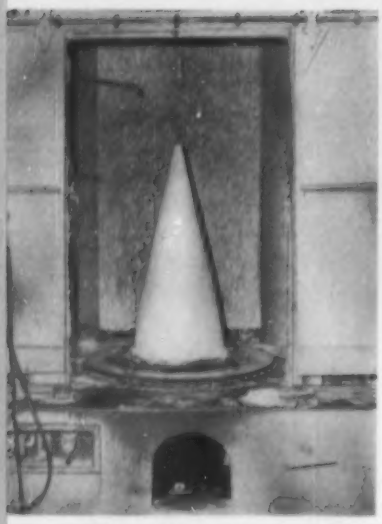
Components can be nested

One of the principal reasons for designing this tank in sections was to facilitate shipment of the tank components and field assembly as required. All five of the basic moldings may be nested, reducing shipping space to a minimum. Field assembly, however, particularly under combat conditions, poses a number of problems with the present method, under which parts are joined by means of an adhesive. Research is now in progress at Molded Products on mechanical methods of tank assembly which would simplify tank fabrication in the field.

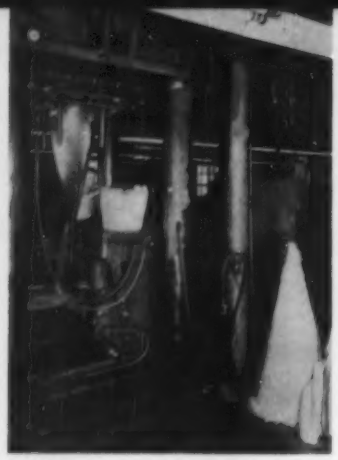
Preforming process

In producing the three center sections and the nose and tail components which make up each finished tank, Molded Products utilizes both glass mat, precut to size and stitched into the necessary number of layers, and preforms made from cut rovings. The preform technique is used for both the nose and tail sections, as well as for the ring-like components

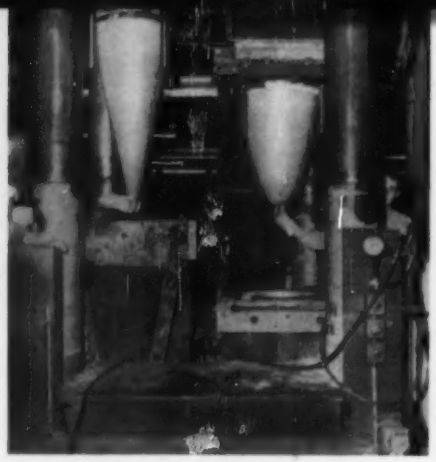
Tank weighs 115 lb. and has 225-gal. capacity; young lady is holding tail section



Tail section preform in position on mandrel in preform chamber



Molding tail section in a 2000-ton compression press



Tail and nose sections are molded simultaneously in this set-up

which form the two bulkheads used in each tank.

For these three types of parts, preforms are produced on perforated metal mandrels rotating within a vacuum chamber. Fibrous glass rovings, fed into these enclosures, are chopped into short lengths and sucked down onto the mandrels as they revolve. Binder is automatically sprayed into the preform booths, causing the loose fibers to bond to each other on the mandrels. Upon removal from the vacuum booths, the preforms are conveyed through an oven, allowing the binder to set. Thus the preforms can be handled without damage prior to molding. An inspection with a powerful light immediately shows up any thin sections or faulty distribution of chopped fibers.

Actual molding of the reinforced plastics parts follows. The bulkhead pieces, measuring approximately 23 in. in diameter and having a deep flange along the outer edge, are compression molded in single-cavity dies.

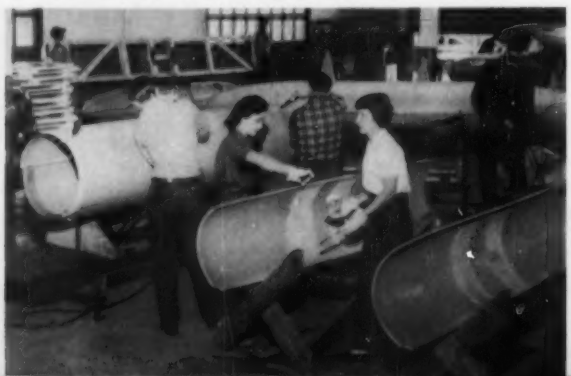
Layers of glass mat are used in molding the three components which, when assembled, form the center section of the tank. All of these parts measure approximately 97 in. long in the standard 225-gal. tank. The wall section of the top piece, to which the metal fittings carrying the entire weight of the tank are attached, is 0.200 inch. The right and left center sections have a wall section of 0.100 inch. All three parts are made with lap joints along the edges, so that a strong adhesive bond may be effected between the center section components themselves and between the center section and the nose and tail moldings.

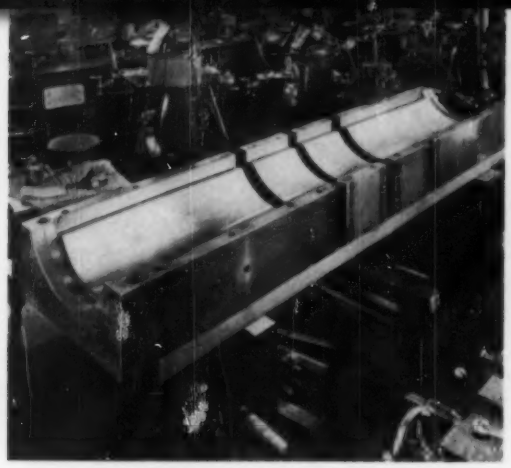
Twin molds used

The left and right center section components of the tank are produced in twin molds mounted in a compression press with a capacity of 3000 tons and a maximum platen area 72 by 193 inches. Relatively shallow in draft, the two parts have a total area of approximately 2800 sq. inches. Two operators, working from opposite sides of the giant press, arrange the stitched, precut glass mat in the

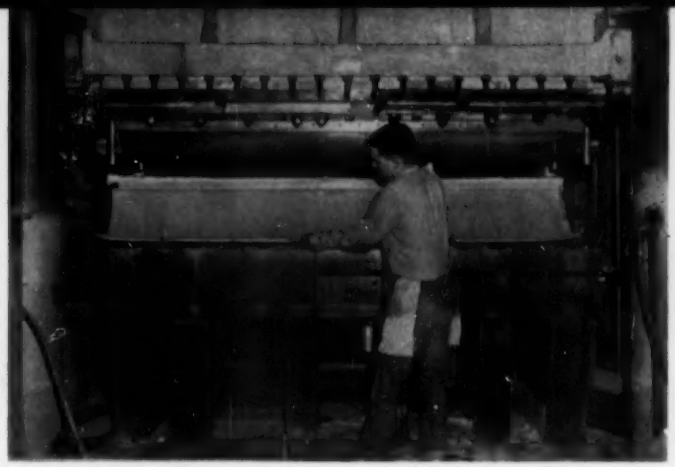
Bulkheads, formed by joining two moldings back to back, are assembled to top center section

Final assembly area; tanks in various stages of completion rest on supporting racks





Sectionalized cavity for center section permits tank capacity changes



Top center section with 0.200-in. wall thickness is removed from 2000-ton compression press after molding

cavities and pour over them a measured quantity of flexible-type polyester resin. The resin charge is added to the mat according to a definite pattern which provides even distribution in the finished part. Added thickness along the edges, where the lap joint is involved, is provided by separate strips of mat sewed into the layup at these points.

The heavier-wall top center section of the tank is similarly molded on a 2000-ton compression press, using a single-cavity mold. The punch and cavity of this mold are also made in sections so that the same basic tool may be used in molding tanks of different capacities. Molding is scheduled so that one of these top sections is produced for each pair of lower sections from the other press.

After molding, each center section part is edge trimmed and sanded as required and placed on a fixture where it is tested for possible leaks in the plastic skin. With the panel clamped down against a frame having a rubber gasket around the edge, air pressure at a total of 7 p.s.i. is introduced beneath the part, to the top of which a soap solution has been applied. Any leaks or imperfections in the panel are revealed by the appearance of bubbles on the exterior surface. All panels are air tested in this manner before being transferred to the assembly area. Minor leaks may be sealed by applying epoxy resin.

Deep draft parts

A somewhat different molding problem is involved in molding the nose and tail sections of the jettisonable plastic fuel tank. Both of these are very deep draft parts having a maximum diameter of approximately 23 inches. They require considerable "daylight" beneath the press so that the preforms may be placed in the cavities and the finished pieces removed at the end of the molding (*To page* 239)

Finished tanks in test cages are pressure-tested for leaks at 15 p.s.i. maximum

Slosh and vibration test is conducted on special table. (All photos, Admiral Corp.)

1930 1932 1934 1935 1939

Early shaver housings were compression molded of phenolic (top photo, this page). Since 1940 (top photo, facing page), housings have been compression molded of urea, with the exception of the two latest models (top right on facing page) which are transfer molded of melamine. (Photos, Schick, Inc.)

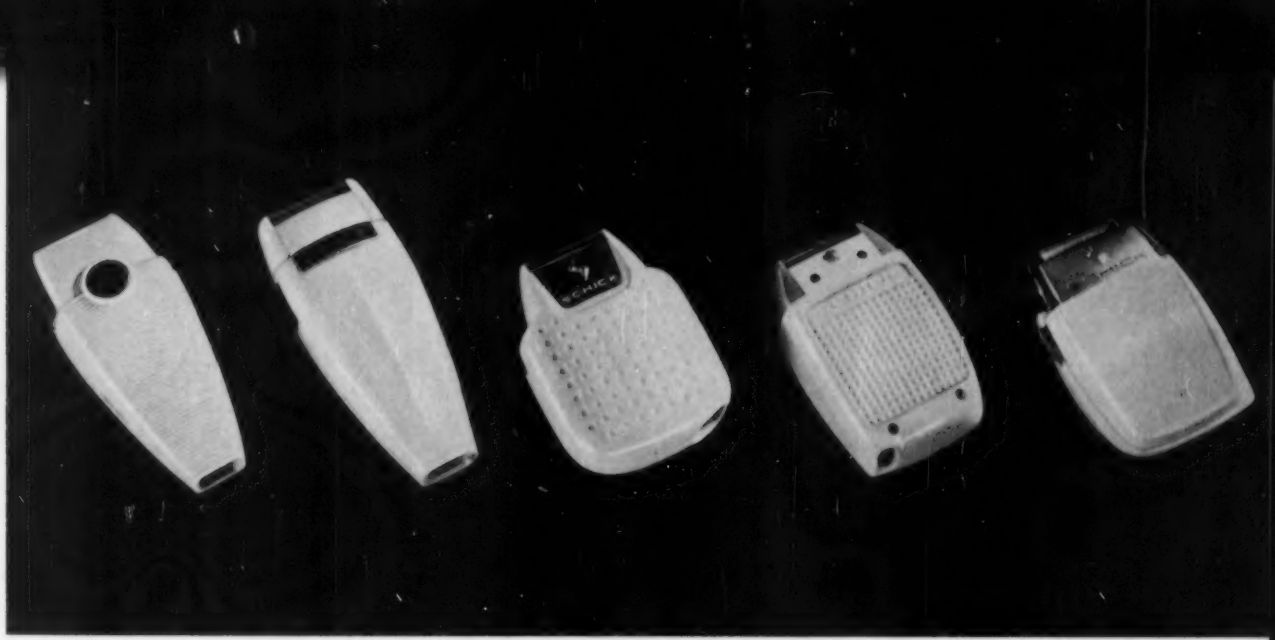
The case of the Schick Shaver

Only plastics could do the job, but a change in color and design demanded switches in material and molding method

A quarter of a century ago Colonel Jacob Schick began commercial production of his first electric shaver and thus became a pioneer in a new industry that today leads all other small appliances in dollar volume of sales. *Electrical Merchandising,* in their annual statistical and marketing issue, states that during 1954 a total of 3,950,000 shavers were sold having a retail value of $108,625,000. Further, it is predicted that sales in 1955 will jump to 4½ million shavers.

Always in thermosets

Since the first model was made in 1930, all Schick shavers have been housed in thermosetting plastics: first in phenolics, then in urea, and finally, today, in melamine. Why has the company stuck to plastics housings throughout all these years? Norman Gray, assistant to the Schick president, has given a clear-cut answer to that question. Mr. Gray, formerly chief engineer and, in that capacity, responsible for the design and materials of construction for practically all the shaver models up to and including their anniversary model, the Schick "25," had this to say: "No other material could give us in one unit a dimensionally accurate bed plate or chassis on the inside and, at the same time, a beautiful, easy to hold handle on the outside. Where could we get another material which makes possible the use of any design, any texture, and any color; which, with no after treatment, is completely resistant to perspiration, before and after shaving aids and lotions, rusting, tarnishing, and scratching; and



1940 1948 1950 1954 1955

which also has the required mechanical and electrical properties?"

While the 10 shaver models shown on these pages do not include every model Schick has made, they do show all the major design changes made from the beginning to date.

The shaver at the extreme left was introduced in 1930 and the model carried through for two years. Six hundred of these shavers were manufactured; they retailed at $25.00 each. Twenty-four years later, the net sales of Schick, Inc., and associated companies rose to $20½ million and their goal for 1955 is $25 million.

More eye appeal

All the shaver models shown in the photo on the facing page were housed in compression molded phenolic cases and covers. Shortly before 1940, Raymond Loewy was commissioned to redesign the shaver. His goal was more eye appeal and, at the same time, a more functional "handle." The model at the left in the photo above was the result. Because the color specified was white, it was necessary to change the material specification to urea. This material has been used continuously for all the models shown in the photo above until the latest models "55" and "25," shown at the right in the photo above.

Because the design of the housing of the model "25" called for an undercut in the case for the connecting plug opening, it became necessary to switch from compression to transfer molding. This method of molding is a great deal more efficient when undercuts are being molded, especially if the mold component must, of necessity, be of comparatively small cross-section and thus subject to breakage due to the strain imposed on it during mold fill-out. Because urea does not readily mold satisfactorily by transfer, it was necessary to switch over to melamine for the case. In order to eliminate any color matching problems between case and cover, it was recommended that melamine be

Fig. 1: Some of the surface textures tried on latest shaver housing. (Photo, Schick, Inc.)

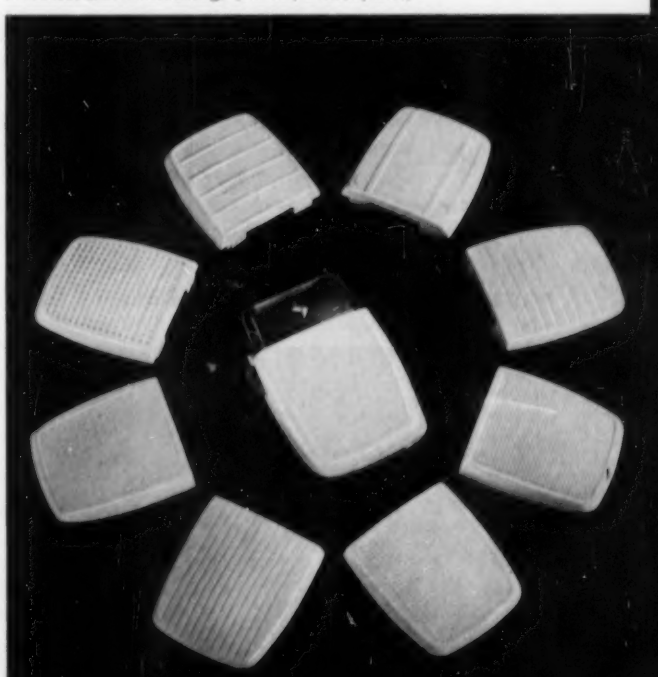


Fig. 2: Loading fixture for placing inserts on pins

Fig. 3: Melamine preforms are positioned on top of force plugs

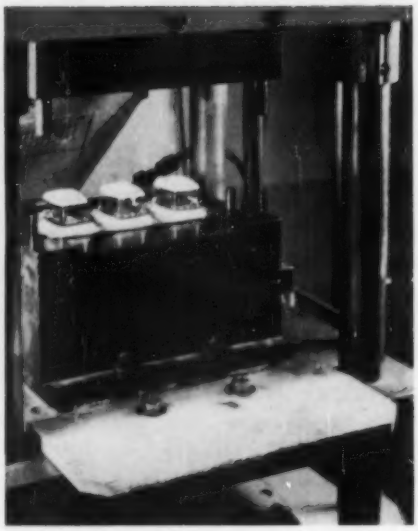


Fig. 4: Three covers are held raised above the force plugs

used for the cover also, even though this piece was to be compression molded.

Texture treatments

In designing the "25," many different texture treatments were tried by machining the surface of a number of molded housing components. Several of these are shown in Fig. 1, along with a complete shaver with a housing of the accepted design. Note how the lines in the housing draw the eye directly to the shaver head and how the contrasting color of the head plate tends to make it appear that the head is much larger than it really is. This design feature was sought after for competitive reasons, since most other shavers actually have a larger head surface. Even though it does not necessarily follow that their shaving efficiency is any greater because of this feature, it has been a good selling point; hence Schick's desire to give the head a more massive appearance.

All covers are molded in three-cavity compression molds while all cases are produced in four-cavity transfer molds. Since threaded inserts are molded-in, Shaw Insulator devised loading fixtures which accurately place the inserts on the mold pins (Fig. 2). The press shown requires the full time of one man for operation since so much of his time is required for hand-loading the inserts into the fixture. The engineering department at Shaw, one of the molders, has designed a machine which automatically loads the loading fixture with the proper inserts. One of these machines is now

Fig. 8: Male half of four-cavity transfer mold with inserts in position

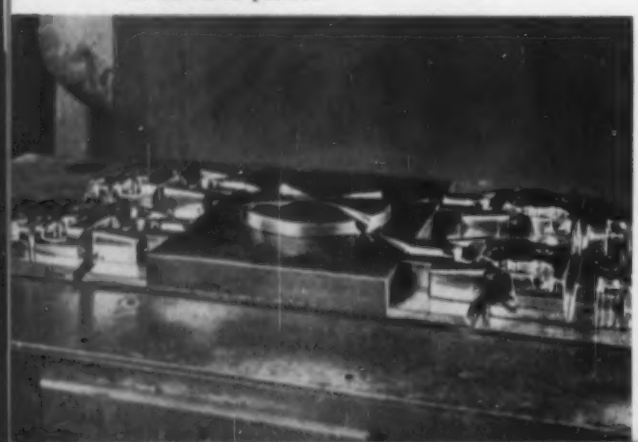


Fig. 9: Complete shot, with cull, runners, and cases about to be removed from the press

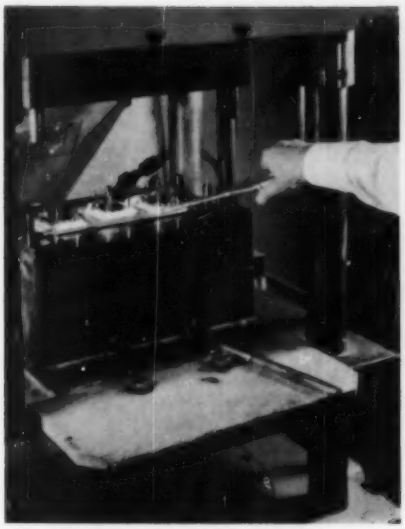


Fig. 5: Flash around plugs is blown off with air

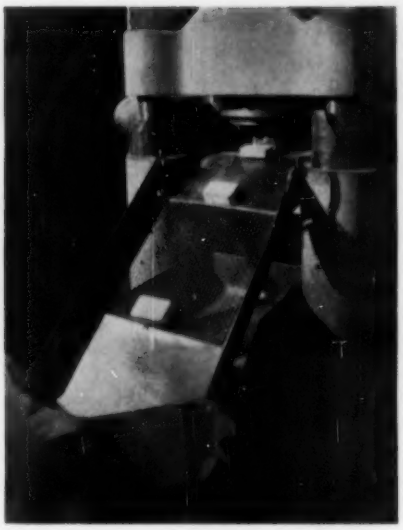


Fig. 6: Cover preforms are made in single-stroke preformer

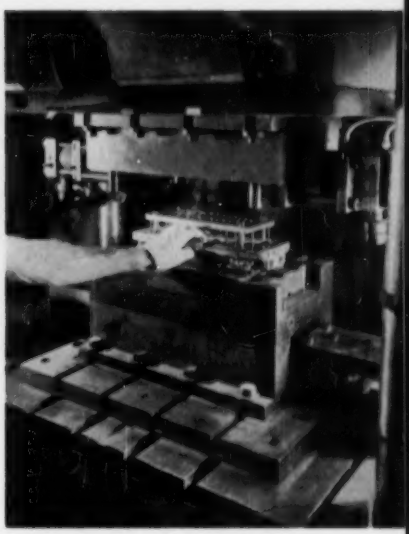


Fig. 7: Loading fixture is used to position inserts on plugs

in operation and is so efficient that one operator handles two presses with less effort than is required for the one-operator, one-press setup. It is obvious that this automation feature, when installed in sufficient numbers, will give this molder a competitive edge.

After the inserts are loaded, preforms of melamine are positioned on top of the force plugs (Fig. 3) and the press run through its semi-automatic molding cycle. When the mold opening is complete, the three covers are held raised from the force plugs (Fig. 4) with most of the flash remaining around the plugs. The sharp "cut-off" leaves a minimum of flash for later removal. The flash around the plugs is blown off with compressed air (Fig. 5)

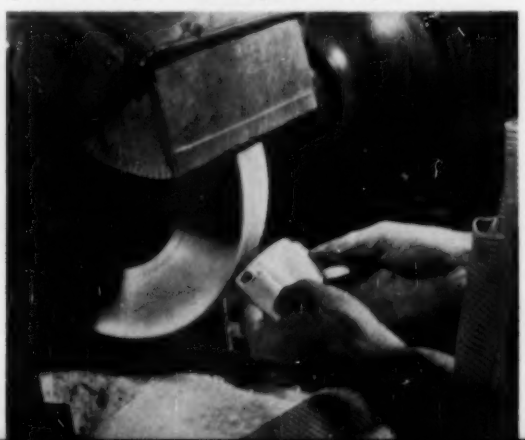
Preforms are also used for molding the cases and, like those for the covers, they are made in a single stroke preformer (Fig. 6) which is enclosed in a dustproof, pressurized room. In molding, the inserts are mechanically positioned on the plugs (Fig. 7) with the same type fixture used for the cover mold. A close-up of the four-cavity transfer mold (Fig. 8) shows the male half with the inserts in position on their pins. Figure 9 shows a complete shot.

Flash is removed and the parting line smoothed-up (Fig. 10), after which the parting line is polished and an additional high luster given the surface by buffing (Fig. 11).

Credits: Molders—Shaw Insulator Co., Irvington, N. J., and Waterbury Cos., Inc., Waterbury, Conn. Material (for model "25") — American Cyanamid Co.

Fig. 10: Flash is removed and parting line smoothed in finishing operation

Fig. 11: Buffing adds luster. (Photos on this spread courtesy American Cyanamid Co.)



Solar battery uses plastics

Late last year for the first time the sun—ultimate source of all power which man has at his disposal—began furnishing power directly to a telephone line. The power was collected from the sun's rays and transferred to the line by a solar battery developed by Bell Telephone Laboratories, New York. And in both the solar battery itself and the storage battery which collects excess current from the former, a number of plastic components are used.

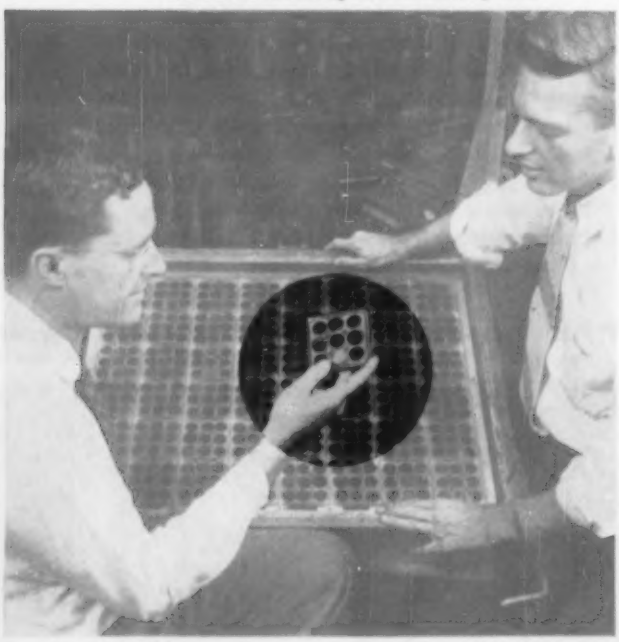
The energy from the sun is turned into electricity through silicon cells which are literally wafers of silicon. Nine of these wafers comprise a module and each individual module contains silicone oil. Forty-eight modules are used for the solar battery now under trial. The cover of each module is machined from ¾ in. thick acrylic sheets, with the cell area cut to 1/16 in. in thickness, and these are then sealed into position with acrylic cement. Styrofoam 22, machined to fit, fills the base of the aluminum housing in which the silicon cell modules are placed.

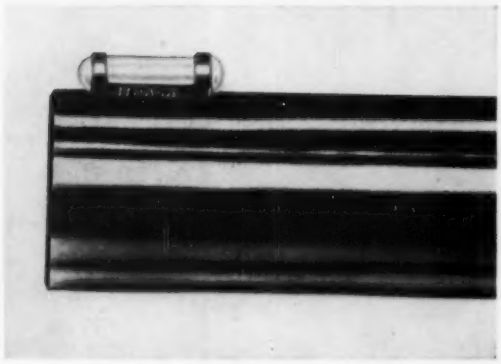
The coaxial cable used to connect the solar battery with its storage battery is made with polyethylene and further insulated with a vinyl outer jacket; the storage battery has an acrylic cover over its individual cells.

Workman mounts solar battery containing numerous plastics parts on telephone pole

Storage battery collects excess current. (Photos, Bell Labs.)

Nine silicon wafers form one module (center) which are linked up to form battery cells





Tiny molded acrylic piece, force-fitted into front gun sight, improves accuracy of aim

Operator removes complete shot of acrylic gunsights from four-cavity injection mold

Gun sight placed atop pencil eraser indicates relative sizes. (Photos, Auburn Button Works)

Small sight

Acrylic gun sight is probably smallest precision piece ever molded in production

Full advantage is taken of the excellent light transmitting properties of acrylic in a new gunsight which is said to improve a shooter's aiming ability under any outdoor lighting conditions. Injection molded of luminescent acrylic resin, the gun sight, which is only ½ in. long and ⅛ in. in diameter, is precision molded—an example of the many items, large or small, which can be quantity produced at low cost through the utilization of efficient molding techniques and equipment.

In use, the red-colored cylindrical plastic insert, which is force-fitted into the front sight, collects and transmits light, producing a bright red-orange glow at the exact center of the unit when viewed with the gun in shooting position; thus, quick, accurate aiming, even under such poor light conditions as dawn, dusk, or heavy overcast, can be achieved.

Credits: Plastic gun sight is molded by Auburn Button Works, Inc., Auburn, N. Y., using Plexiglas supplied by Rohm & Haas Co., Phila., Pa.

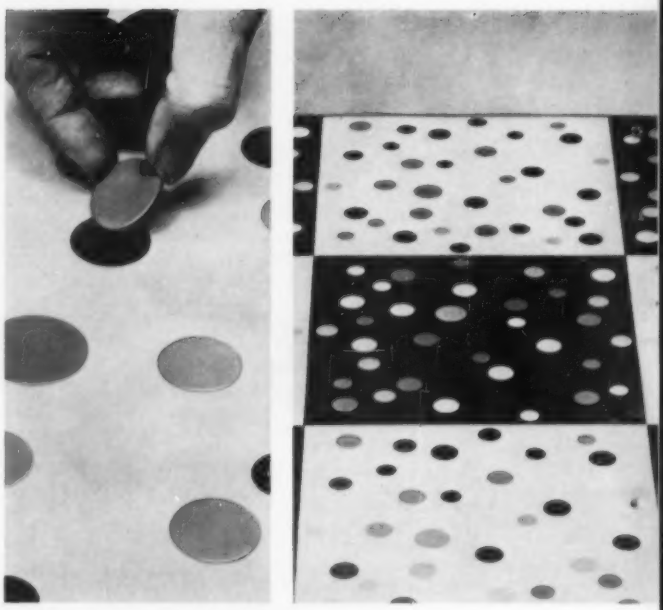
Vinyl polka-dots inlaid in floor covering

Well known for its durability and eye-appeal, vinyl floor coverings are now being used more and more where unusual designs are desired: the latest innovation utilizes inlaid polka-dots to create bright and striking patterns.

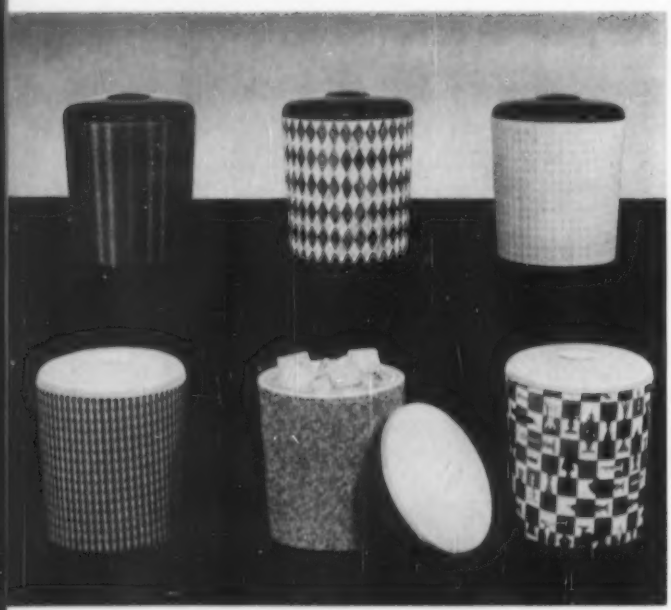
Resistant to scuffing, water, dirt, and grease, the disks fit tightly and are held securely by the same adhesive used to install the tile. Designed in six colors—charcoal, pink, beige, grey, off-white, and turquoise—the 12-in. square tiles each contain 33 dots of three sizes and four colors inlaid in an irregular pattern.

The dots are produced by stamping disks from tile of one color, then filling the holes with disks cut from tile of other colors.

Credits: Tiles are made by Robbins Floor Products, Inc., Tuscambia, Ala. using vinyl supplied by Bakelite Co.



PLASTICS



Molded expandable styrene ice containers

Ice buckets molded of expandable styrene offer excellent insulating properties, large capacity, and decorative exteriors in a variety of bright, attractive designs.

The 2½-qt. styrene ice containers are wrapped with 12-gage vinyl film in various colors—coral, gray, tan, yellow, aqua, and pink—and incorporate lids which are made of expandable styrene covered with vacuum formed styrene sheet. They are guaranteed not to sweat or tarnish.

Methacrylate emulsion is used both as an adhesive and as a barrier to prevent migration of the vinyl plasticizer.

Credits: Ice buckets are molded by Frank Paper Products Corp., 2941 E. Warren Ave., Detroit, Mich., using expandable polystyrene supplied by Koppers Co., Inc., Pittsburgh, Pa. Vinyl sheets supplied by Harte and Co., Inc., New York, N.Y.

Golf ball retriever eliminates all bending

Designed to eliminate bending in retrieving golf balls, an all-plastics device takes some of the strain out of the game. The 3-ft. long tube, extruded of cellulose acetate butyrate, is equipped with a molded flexible polyethylene ring and is wielded somewhat like a cane: a slight downward pressure centers the ball and traps it in the transparent tube.

The device holds 20 balls; a polyethylene cap at the top may be removed for unloading. Rustproof and light weight, it is easily carried in the golf bag without damage to bag or clubs.

Credits: Golf ball Pic'r Up'r is made by W. G. Watson, Effingham, Ill.; Tenite butyrate tube extruded by Anesite Co., Chicago, Ill.; Tenite polyethylene molded by Ken Hagen Mfg. Co., Paris, Ill.; Tenite plastics supplied by Eastman Chemical Products, Inc., Kingsport, Tenn.

PRODUCTS

Phenolic pistol-grip for welding gun

Utilizing a pistol-grip stock molded of glass-filled phenolic resins, stud welding applications in construction and industry are being widened by a new type of gun that welds steel studs up to 1¼ in. in diameter in the field. The pistol-grip is less bulky, has high heat resistance, and good electrical properties.

As an indication of its versatility, the gun will weld studs 1 in. in diameter in a split second; it is also capable of welding studs up to a yard long, to hold concrete forms in tunnel construction, for example.

Credits: Fiberite material, compounded of Bakelite phenolic resins, is used in the stock of the gun produced by Nelson Stud Welding Div., Gregory Industries, Inc., Lorain, Ohio; molding is by Plastic Research Products Div., Grimes Mfg. Co.

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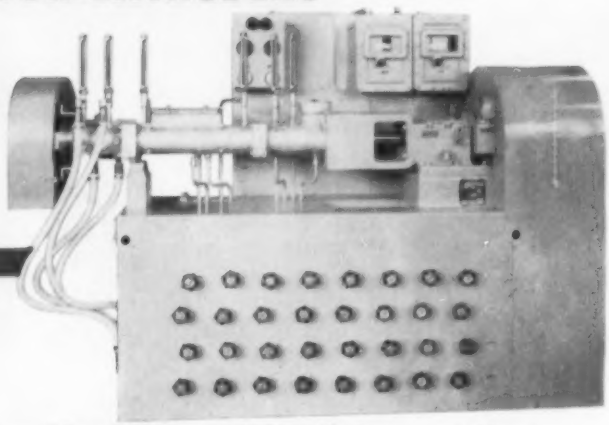

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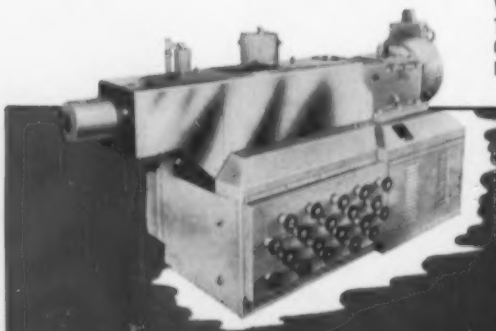

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Plastics Engineering

F. B. Stanley, Engineering Editor

Polyliner improves injection molding

Replacing the conventional torpedo in injection cylinders, new device greatly increases speed, improves quality, and reduces pressure drop

By E. C. Bernhardt[†] *and L. Paggi*[†]

Increased injection machine capacity and more uniform melt temperatures, plus faster injection and shorter cycles with existing equipment, become possible with a basically new injection cylinder torpedo known as the "polyliner." Before describing this new device, which replaces the conventional torpedo, it will be helpful to analyze the principal problems encountered in the injection molding machine, especially as they pertain to the cylinder.

Instrumentation

Significant advances in instrumentation have made it possible to define accurately the operating characteristics of an injection molding machine. The fundamentals of the process have been studied, and sensitive instruments permit an accurate analysis of the performance of the various machine components.[1, 2]

For example, to gain a better understanding of the characteristics on an injection cylinder, pressure-measuring devices have been installed at the nozzle of an injection machine and in the hydraulic system supplying pressure to the ram. When the pressures measured at these locations are recorded, it has been found that only approximately 20% of the pressure available at the ram is effectively transmitted to the nozzle during the injection stroke.

The resistance to flow between ram and nozzle must, therefore, be very great. The major part of this loss of pressure within the injection cylinder occurs at the beginning of the stroke, when the unmelted molding powder is

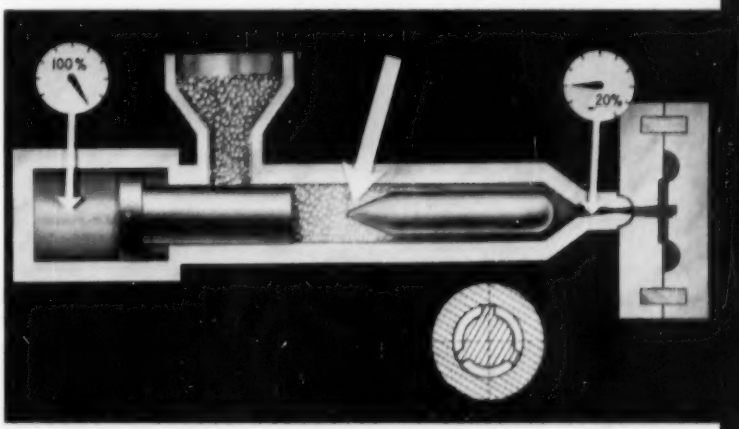


Fig. 1: Injection cylinder, showing pressure loss with torpedo; heavy arrow shows area of greatest resistance to flow

*Reg. U. S. Pat. Off.

†Sales Service Laboratory, Polychemicals Dept., E. I. du Pont de Nemours & Co., Inc.

1"The Role of Pressure, Temperature, and Time in the Injection Molding Process," by G. D. Gilmore and R. S. Spencer. (Modern Plastics 27, 143, April 1950)

2"Temperature and Pressure Measurements in the Injection Machine Heating Cylinder," by C. E. Beyer, R. B. Dahl, and R. B. McKee. (Modern Plastics 32, 127, June 1955)

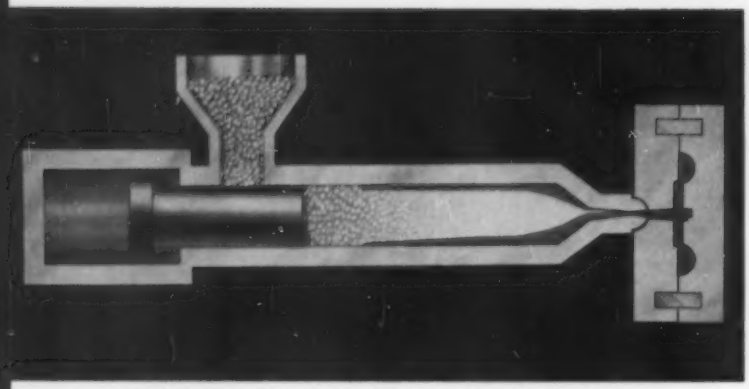


Fig. 2: Diagram of injection cylinder with torpedo removed. Only outside layer of plastic is exposed to heat

forced by the injection ram to flow around the nose of the torpedo into the narrow space between the torpedo and the inside wall of the injection cylinder. Relatively little additional resistance to flow is encountered in pushing the polymer the rest of the way through the injection cylinder, the nozzle, and the runners of the mold.

A molder is often faced with the problem of excessive pressure losses between the ram and the mold cavity. These losses can prevent the mold cavity from filling properly and may result in short shots.

Under these circumstances it is logical to do everything possible to exert the greatest possible pressure to make the material flow into the cavities, and to try to make the material entering the mold less viscous so that it flows more easily.

The first step may be to raise the cylinder temperature. Raising the temperature of the cylinder will increase the average stock temperature in the cylinder and consequently will cause the average melt viscosity to drop and the polymer will become more fluid. The hotter and more fluid polymer will require less pressure to push it through the cylinder, resulting in a higher available pressure and a more fluid material at the nozzle.

Frequently it becomes necessary to set the cylinder temperatures above the recommended stable temperature of the resin in order to produce satisfactory moldings at a given cycle. These high cylinder settings may be tolerated because the bulk of the resin never reaches the temperature of the cylinder. Only a very thin film is actually exposed to the cylinder walls. However, there is a limit for cylinder temperatures beyond which decomposition of the material will become excessive.

Under such circumstances there is no alternative but to increase the cycle time. This is undesirable from an economic standpoint.

A longer cycle aids in filling the mold cavities, because it increases the dwell time of the material in the cylinder. This gives the material a better chance to heat up and reach a more uniform temperature throughout. The average viscosity is thus reduced. The more fluid material will require less pressure to push it through the cylinder and the consequently higher available pressure at the nozzle will make it easier to push the material into the mold cavity.

An examination of the cross-section of an injection cylinder shows that the attempt to reduce the resistance to flow within the cylinder by raising the cylinder temperature or increasing the cycle influences primarily the performance of the forward part of the cylinder. This section of the cylinder accounts for only a relatively small percentage of the total loss of pressure. The greatest resistance to flow actually occurs around the nose of the torpedo (arrow, Fig. 1) where the bulk of the resin will always be unmelted and where a high resistance to flow of the material seems unavoidable.

It is likely that the removal of the torpedo from the injection machine in order to reduce the resistance to flow within the cylinder has been considered by many machine designers. This drastic step certainly would reduce the pressure loss in the injection cylinder, but it would give rise to a lot of other problems.

Without a torpedo, only the outside layer of plastic in the machine cylinder would be exposed to heat (Fig. 2). The inside material would stay cold and an extremely non-uniform stock temperature in the nozzle would result. What the torpedo really accomplishes is to flatten out the melt into a shallower stream permitting more uniform heat throughout the entire mass.

Figure 3 shows in a somewhat different way what the torpedo accomplishes. Without the torpedo, the result is a very wide distribution of temperature in the plastic material discharged at the nozzle. The torpedo helps the resin to make more uniform contact with the cylinder wall, and helps to produce a narrower band of stock temperature as shown in the right-hand graph in Fig. 3.

The polyliner

The polyliner previously mentioned was developed as one solution to the many problems which arise when heating polymers inside injection cylinders. The first one was designed and built by L. Paggi in the Sales Service Laboratory of the Polychemicals Dept. of Du Pont.

The polyliner consists of a long sleeve which fits inside the cylinder of the injection machine. The sleeve is closed at its front end (Fig. 4). The device is characterized by two important features: 1) it is perforated; 2) it has longitudinal ribs on its outside surface.

The ribs serve two purposes: 1) they position and support the liner within the cylinder; 2) they provide metal-to-metal contact between the liner and the cylinder wall, so that the liner will absorb heat from the cylinder.

When the polyliner is in use

(Fig. 5), the inside surface of the liner is heated to nearly the same high temperature as the inside wall of the injection cylinder. The ribs on its outside surface provide intimate thermal contact with the cylinder and provide the necessary heat transfer area to maintain its temperature

On the injection cycle, the ram forces largely unmelted molding powder under pressure into the liner. The outside layer of cubes comes in contact with its hot inside wall. This outside layer of molding powder quickly melts and the molten material easily flows through the perforations of the liner. Actually, the liner holds back the unmelted cubes and permits only melted material to pass through the perforations. The melted polymer then flows along the channels between the ribs of the liner toward the nozzle. During this part of its travel it moves in many small-diameter streams in direct contact with the heating cylinder. These many small streams of melt reach the nozzle at a very uniform temperature which corresponds closely to the cylinder setting.

Between injection strokes new molding material held within the polyliner is heated up and melted, so that it can be forced through the holes of the liner and toward the nozzle on the next stroke.

Resistance to flow

In the polyliner the direction of flow of the material is unchanged until *after* it has melted. Unmelted cubes are not forced around any obstruction. As a result, the amount of ram pressure used in forcing the plastic through the first part of the injection cylinder will be lower when using a cylinder equipped with a polyliner than when a normal type torpedo is used. Its use can thus result in a definite increase in the pressure available at the nozzle to fill the mold.

This does not necessarily mean that all cylinders with this type liner will always have less resistance to flow than torpedo-type cylinders. For example, a polyliner with rather small perforations and flutes would use up a lot of the available ram pressure in forcing the plastic through the forward part of the liner so that the over-all pressure loss would remain high. However, it is apparent that such liners can easily be designed to have less resistance to flow than normal torpedos of the same size.

Plasticating capacity

It is apparent from its construction that the new liner takes up less space within a cylinder than a corresponding torpedo. This extra space holds a larger inventory of plastic material which is gradually preheated between shots.

Also, the liner is in intimate thermal contact with the cylinder and readily absorbs heat from it. The very large heat transfer area inside the liner and between the liner and cylinder along the flutes causes the liner to act like a very efficient radiator and substantially increases the heat transfer area within the cylinder.

The combination of greater plastic inventory plus larger heat transfer area results in a higher plasticating or melting capacity for a cylinder equipped with a polyliner.

Melt temperature uniformity

The benefit of uniform melt temperature, mentioned previously, is of very great importance to the molder, and is illustrated in Fig. 6. Both plots represent temperature profiles

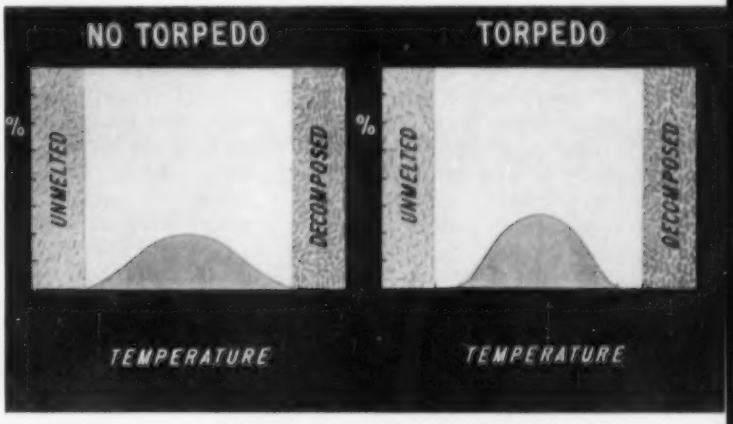


Fig. 3: Temperature distribution in materials discharged at nozzle for cylinders with and without torpedo. Torpedo narrows the temperature spread within a shot

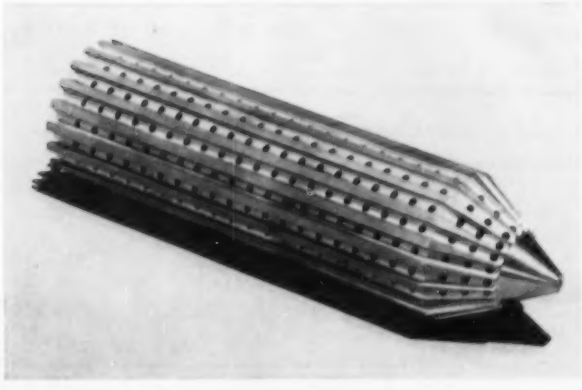


Fig. 4: Replacing the conventional torpedo, the polyliner is a perforated, longitudinally ribbed sleeve that fits inside the injection cylinder

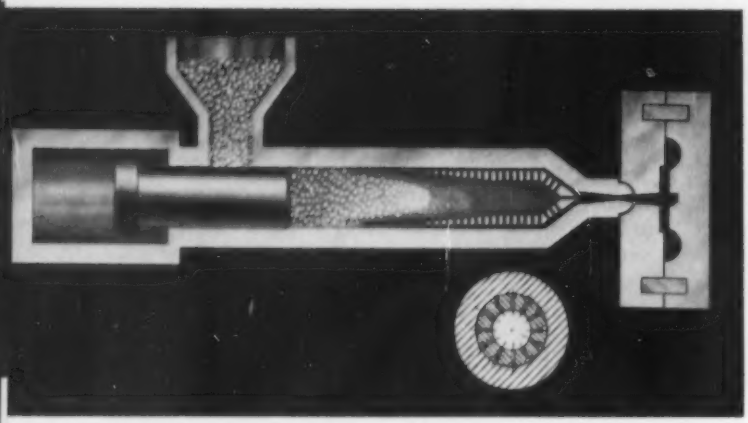


Fig. 5: Diagram of injection cylinder fitted with polyliner whose ribs are in close contact with cylinder wall

of a shot with approximately the same average melt temperature; but in the shot from the torpedo cylinder represented in the first graph the stock temperature has a relatively wide spread, whereas in the second plot, representing a similar shot from a cylinder equipped with a polyliner, the temperature spread is much narrower.

Since the average temperatures of both shots are approximately the same, both shots flow into the mold cavity with equal ease. However, the shot from the torpedo cylinder shows signs of degraded polymer, since some of the resin exceeded the degradation temperature, while the shot from the polyliner is free of degraded material.

The less efficient heat transfer in the torpedo cylinder made it necessary, in the case in point, to set the cylinder temperature considerably above the average desired for the shot. A cylinder temperature above the degradation temperature was required and this caused some of the polymer to decompose. It is obvious that any delay in cycle can cause very serious decomposition.

Cycle time

To obtain the theoretically shortest molding cycle, the plastic should be brought to a maximum temperature only barely above its melting point. This would reduce the time required to heat the resin; and since after the plastic is injected into the cavity, it would have to cool very little to return to its solid phase, the cooling cycle in the mold would also be very short. Fundamentally, therefore, in order to reach a minimum cycle, a molder would want to operate at minimum melt temperature.

The minimum temperature would usually be determined by the pressure available to force the more viscous melt at the lower stock temperature into the mold. Of course, there is a limit beyond which stock temperature cannot be lowered, because eventually extremely high internal stresses, distortions, and poor welds would be encountered within the molded piece and would impair its quality.

It can be shown that the new liner facilitates the operation of a molding machine at lower melt temperatures and at faster cycles without many of the difficulties which might be expected with a torpedo-type cylinder.

If the stock temperature in a torpedo-type cylinder is lowered, the condition quickly arises where occasional particles of unmelted material would be noted in the molded piece. This would be cause for rejects and would force a retreat to higher temperatures and longer cycles.

With the polyliner cylinder, the narrower band of stock temperatures, or greater stock temperature uniformity, makes it possible to lower the temperature (Fig. 7), without encountering unmelted particles.

Another reason why lower operating temperatures and correspondingly higher viscosities can be achieved with a polyliner is that the reduced resistance to flow through the cylinder makes greater ram pressure available to force the more viscous resin into the mold cavity.

By producing more uniform stock temperatures, the new liner also reduces the likelihood of warpage in the molded piece. It is evident that a mold cavity filled with melt of non-uniform temperature will give pieces that shrink non-uniformly and tend to warp, while a shot with melt at uniform temperature will shrink more uniformly.

Summary of advantages

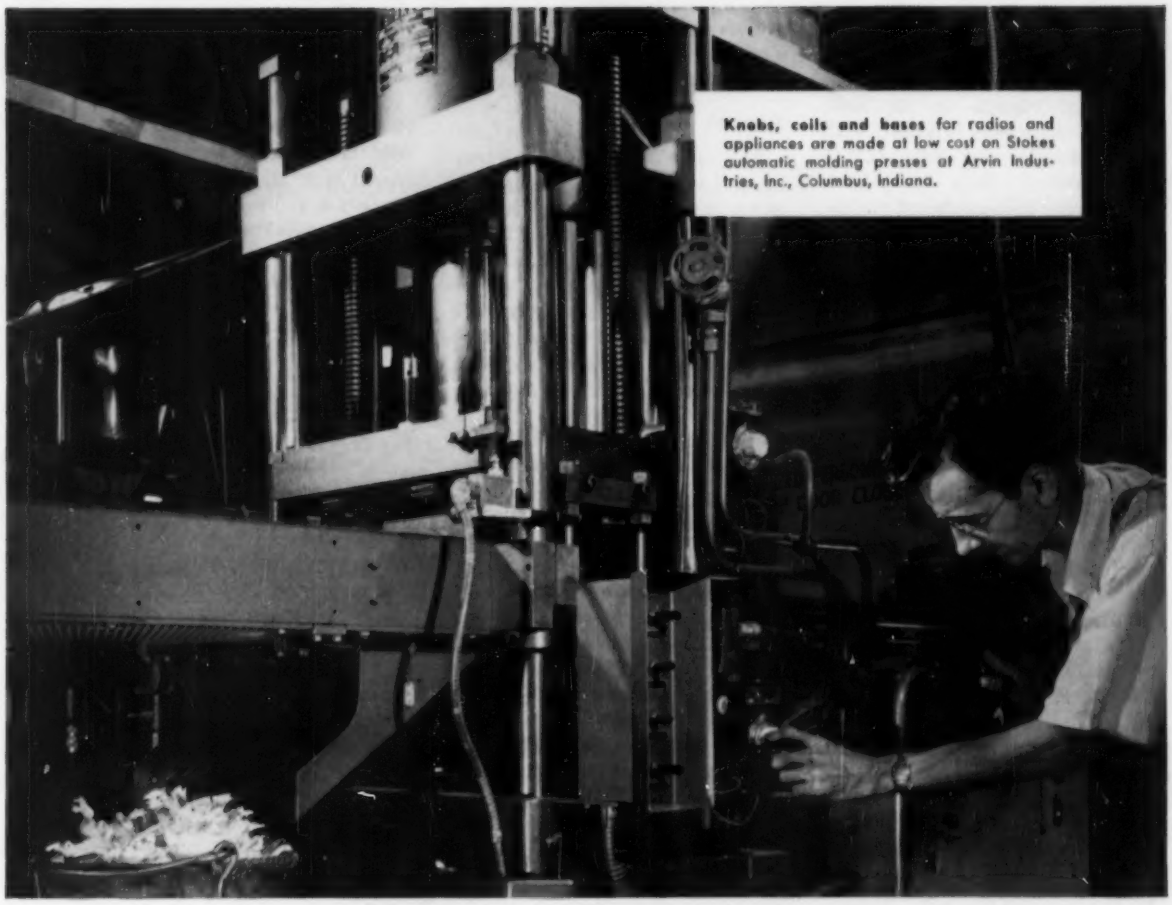
The performance advantages of a polyliner equipped cylinder over a conventional unit may be summarized as follows: 1) it offers less resistance to flow; 2) it has greater plasticating capacity; 3) it produces more uniform melt temperatures.

These primary advantages, in turn, enable the molder to achieve faster cycles and better quality pieces. Typical production increases which may be realized through the use of the new liner are shown in Table I, below.

This table presents perform-

Table I: Polyliner performance

	Over-all cycle		Prod. increase with polyliner
	Torpedo	Polyliner	
	sec.	sec.	%
Lucite	30	14	110
acrylic resin	43	33	30
Zytel	60	30	100
nylon resin	50	40	25



Knobs, coils and bases for radios and appliances are made at low cost on Stokes automatic molding presses at Arvin Industries, Inc., Columbus, Indiana.

Automatic Molding cuts costs for Arvin Industries

Typical appliance parts made by automatic molding at Arvin.

Stokes automatics produce uniform, high quality radio and appliance parts.

For 23 years, Arvin Industries, Inc., has been a leading supplier of portable electric heaters for the home. To maintain this pre-eminent position, costs must be kept under strict control so that a quality product can be sold at an attractive price.

Stokes automatic compression molding presses are helping Arvin hold the line on prices. The Model 741 press molds temperature control knobs for Arvin heaters; a Stokes Model 800 turns out a variety of plastic parts for radios, another important Arvin product. Fully automatic operation means low labor charges for these Stokes machines and a substantial cost saving over semi-automatic operation.

Stokes has had 20 years experience in the design and application of presses for automatic molding. The latest achievement of this unequalled engineering background is a new rope feeding attachment on the 50-ton Model 741 for the automatic molding of glass-fiber reinforced polyester resins. Another recent Stokes modification of the Model 741 makes possible the automatic molding of coil forms and other parts with undercuts, affording molders vast new fields of opportunity.

You may be surprised at the cost advantages which lie in automatic molding. Send for Stokes revised brochure on Fully Automatic Injection and Compression Molding and Bulletin 525 describing the Models 741 and 800.

F. J. Stokes Machine Co., Phila. 20, Pa.

OFFICES IN PRINCIPAL CITIES, REPRESENTATIVES THROUGHOUT THE WORLD

STOKES

ance data of a polyliner and a torpedo in a 12-oz. machine, covering both a plastic which is relatively viscous in its melt stage (Lucite acrylic resin) and one which is very fluid (Zytel nylon resin). Both heavy-sectioned and thin-sectioned molding are represented. These data illustrate the economic advantages which the new liner offers to the molder.

We have not encountered any instance where the installation of a polyliner has failed to increase the production of an existing machine.

Design of liner

The design described in this paper has been found practical and useful. However, many other ways to incorporate the features of the polyliner in an injection cylinder readily suggest themselves. Even single-piece constructions, where the liner forms an integral part of the cylinder itself, have been considered. Of the various possible designs, the one described here and shown in Fig. 4 is the easiest to install in existing cylinders.

Typical dimensions

The liner shown in Fig. 4 was made for a 12-oz. injection machine. It is 10 in. long and has 20 ribs and 20 longitudinal flutes. The flutes have a ⅛-in. radius, and the width of the ribs is approximately 5/16 inch. There are 23 perforations, ⅛ in. in diameter and ⅜ in. apart, in each flute, or a total of 460 perforations.

The proper dimensions for the perforations and the flutes must be carefully selected. If the passages are too small, injection pressure will be lost; if the passages are too large, unmelted molding material can pass through into the mold.

To design a polyliner, specific molding conditions have to be accurately defined. It is necessary to consider the injection speed, melt viscosity, and available ram pressure. This would lead to a theoretical optimum design for a particular injection machine, mold, polymer, and temperature.

The basic equations to calculate the pressure drop across the polyliner during the mold fill period are given below. These fundamental relationships are based on isothermal conditions in the liner, but allow for the non-Newtonian behavior of the polymer.

For holes:

$$\Delta p = \frac{8LV\eta_0}{\pi N\theta r^4\left[1+k\left(\frac{\Delta pr}{2L}\right)^n\right]}$$

For flutes:

$$\Delta p = \frac{8LV\eta_0}{N\theta r^4\left[1+k\left(\frac{\Delta pr}{1.6L}\right)^n\right]}$$

where Δp = pressure drop; L = length of holes or flutes; V = total volume of one shot; η_0 = Newtonian viscosity of plastic at the temperature used (cylinder temperature); N = total number of holes or flutes; θ = mold fill time; r = radius of holes or semi-cir-

(*To page* 243)

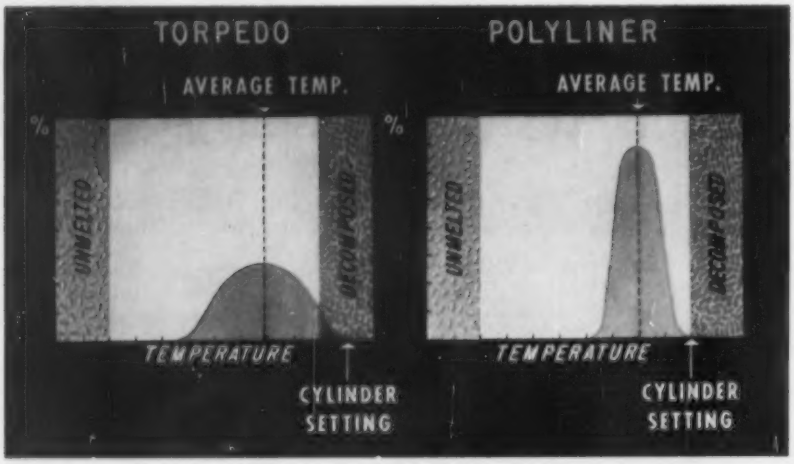


Fig. 6: Temperature distribution in materials from cylinders with torpedo and polyliner. Both shots have same average melt temperature. Polyliner shot has narrower temperature distribution and is free from degraded material

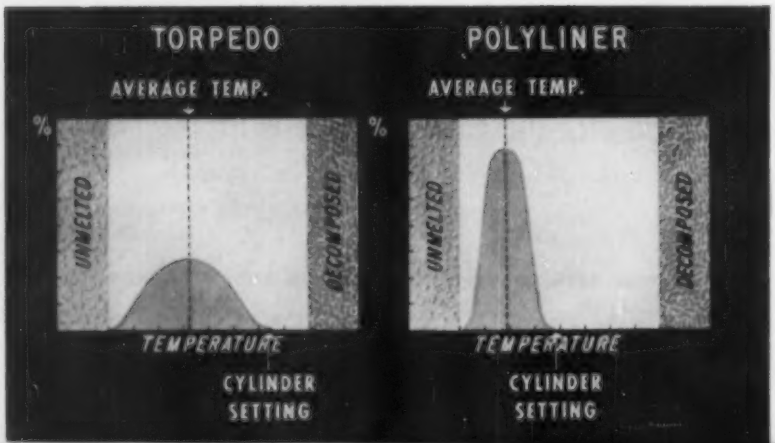


Fig. 7: Temperature distribution in materials discharged from cylinders with torpedo and polyliner. Polyliner permits lower average melt temperatures than torpedo without causing unmelted particles in shot. (All illustrations, Du Pont)

Paste extrusion

Additive to finely powdered tetrafluoroethylene resin permits production of thin-wall tubing by ram extrusion

By Wallace B. Thompson, Jr. and Robert E. Stabler**

Tetrafluoroethylene resin (Teflon) offers a unique combination of properties of particular importance to the chemical and electrical industries. Teflon is inert to almost all chemicals and solvents, is mechanically strong and tough, has exceptional dielectric properties, and can be used at temperatures from —450 to 500° F.

Early in the resin's history, this combination of properties indicated that one of the specific areas where Teflon could provide better performance than previously used materials was in the form of tubing or hose for conveying corrosive liquids over a wide temperature range.

Initially, limitations on the production of these forms were imposed by processing methods. Teflon is usually formed below its melting point and then coalesced into a homogeneous, tough structure by sintering above the 620° F. transition temperature. This method severely limits the rate of extrusion and thinness of wall section.

A method for overcoming these two limitations has been developed in Du Pont laboratories. Briefly, it calls for the use of an extrusion aid, such as naphtha or white oil, which is added to a finely powdered form of the Teflon resin. Immediately before sintering, the extrusion aid is completely vaporized.

This new method was first put to practical test in wire coating. It proved effective and such coated wire has been sold commercially by Surprenant Manufacturing Co. for several years.

At the same time, the development of this technique for extruding hose and tubing continued. Field tests were made in the plants of a number of processors and additional refinements of the technique were made. As early as February 1954, one of these processors, Resistoflex Corp., was selling extruded hose made of Teflon tetrafluoroethylene resin by this method. As had been anticipated, its production satisfied pressing needs in the field of chemicals and aviation where it is now in widespread use. It is currently used in applications where working pressures are up to 1000 p.s.i. and, with braided steel armor for reinforcement, with pressures up to 3000 p.s.i.

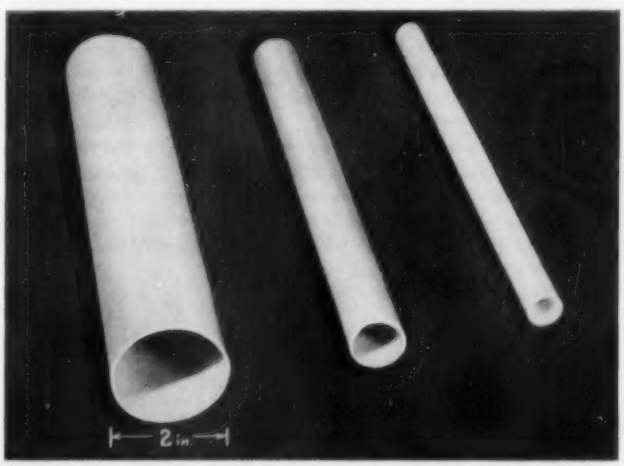
The new method for producing thin-wall tetrafluoroethylene tubing is based on the use of Teflon 6, a fine powder which is compounded with a liquid organic extrusion aid to permit easy formation of the desired shape below the melting point. The composition can be forced through small dies under practical manufacturing conditions.

In this process, the extrusion aid is blended with Teflon, the composition is preformed to a cylindrical billet under 100 to 300 p.s.i. pressure, and the preform is then placed in a ram-type extruder. The composition is forced through a forming die, by the ram, the extrusion aid is vaporized (at 200 to 575° F.), and finally the extrudate is sintered and cooled in the form of finished tubing. Tubing with wall thicknesses ranging from 0.010 to 0.100 in. can be produced.

Handling of material

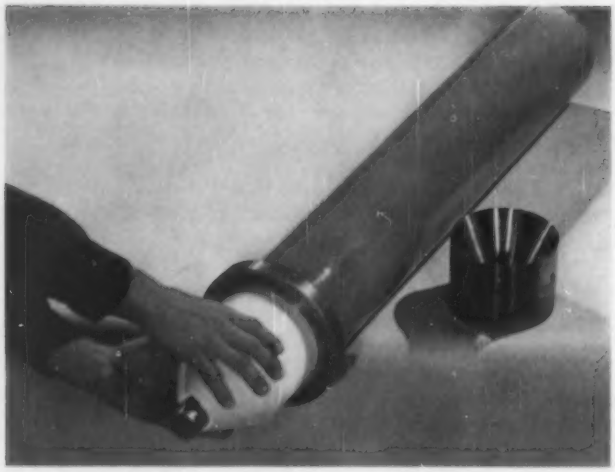
Teflon 6 sometimes becomes compacted during shipping and storage. When this occurs, lumps should be gently broken and screened. In order to minimize compacting and the formation of lumps, storage temperatures above 90° F. and below 70° F. should be avoided.

The temperature throughout the powder should be 70° F. or higher for at least 2 hr. before use.



Thin-wall tetrafluoroethylene tubes produced by extruding Teflon 6 compounded with an extrusion aid

*Polychemicals Dept., E. I. du Pont de Nemours & Co., Inc.



Teflon composition preform is removed from cylinder in which it was compacted by slowly applied pressure

Before blending with extrusion aid, Teflon 6 should be poured from its container onto a 4-mesh screen, and the screen vibrated just long enough to allow most of the fine powder to pass through. Excessive working of the polymer at this point should be avoided. Over-working can be caused even by scooping, instead of pouring, the powder from the shipping container; by using too fine a screen (e.g., 10-mesh) or by vibrating the screen for too long a time. Any lumps that do not pass through the screen should be placed in a clean container, filling it to no more than one-third its capacity. Almost any type of container such as a wide-mouth bottle or a fibre drum will do. The container should be closed and shaken in such a way that the lumps are thrown vigorously against the end walls. This agitation is generally sufficient to reduce the lumps so that the powder can be sifted through the screen. This powder should be added to the material that passed through the screen initially.

During these handling stages, contamination should be avoided; it may result in structural flaws, specks, or general discoloration.

Preparation of compound

The addition of extrusion aids to fine powder Teflon tetrafluoroethylene resin provides compositions which can be extruded at reasonable pressures. Many materials can perform this function. Those which vaporize readily, without leaving a carbon residue, are preferred. Liquids and solutions having viscosities in the range of 0.5 to 100 cp. have been used, but those having viscosities of 0.5 to 5 cp. are preferred. The main requirements of a good extrusion aid are that it be easy to incorporate in the resin, that it vaporize completely and rapidly below the sintering temperature of the resin, and that it leave little or no carbon residue.

VM&P grade naphtha[1] is recommended for general use as an extrusion aid. White oil has also been used extensively, especially for critical thin-section extrusions. Its use, however, imposes a minor production penalty because of the slower evaporation rate; more important, it tends to oxidize and deposit tars in and around the exhaust system.

If practical, it is highly desirable to store and compound the Teflon with the extrusion aid in an air conditioned room. This will minimize extrusion variability and contamination. The steps in compounding are as follows:

1) Provide a clean, dry container with a tight closure of suitable size and proportions. For a 1000-g. batch of Teflon (about 2 lb.) a 1-gal., wide-mouth bottle is suitable. For a 5000-g. batch (about 11 lb.) a 5-gal., wide-mouth bottle is adequate. The bottle should have a screw cap closure, preferably with a cap liner of metal foil; waxed paper and polyethylene liners are both affected by naphtha.

2) Weigh a suitable quantity of the tetrafluoroethylene resin which has been screened, and pour it into the container. Using a spatula or other suitable tool, gently move the material so as to form a cavity or hollow at the center of the powder. Pour a weighed quantity of extrusion aid all at once into this hollow, taking care that the liquid does not wet the walls of the container. The ingredients should be weighed with a precision of at least ±0.5%, preferably ±0.2 percent. If the extrusion aid is naphtha or a similarly volatile liquid, it should be sealed after weighing or all of it should be used immediately.

3) As soon as the puddle of extrusion aid disappears, close the container and shake it to minimize wetting the walls of the container with liquid.

4) Place the container, with its screw cap taped in place, on a suitable rolling device such as a pair of parallel horizontal rollers driven in the same direction. For

Table I: Naphtha level in compounding

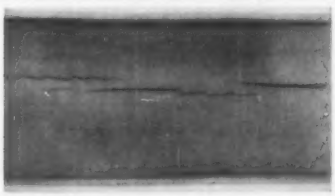
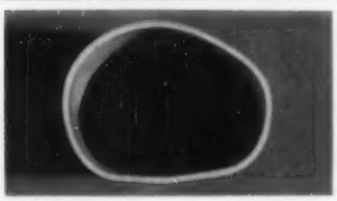
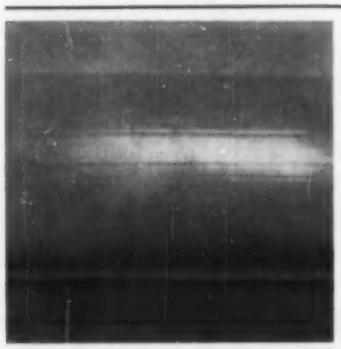
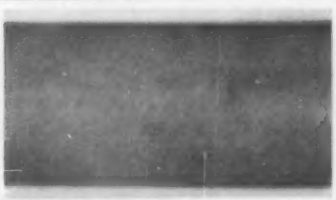
Reduction ratio[1]	*Weight %*[2]	*Naphtha content Parts naphtha/100 parts Teflon*
20	16.0	19.0
50	16.5	19.8
100	17.0	20.4
250	17.5	21.2
500	18.0	22.0
1000	19.0	23.5
2000	20.0	25.0

[1]Reduction ratio is the ratio of the cross-sectional area of the extruder cylinder to which the preform is charged to that of the extrudate.
[2]Percent naphtha based on the weight of naphtha plus Teflon.

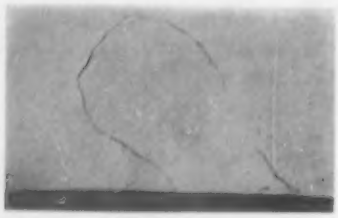
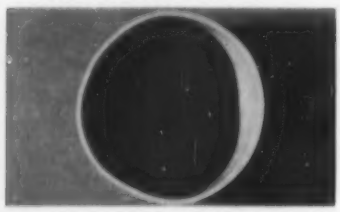
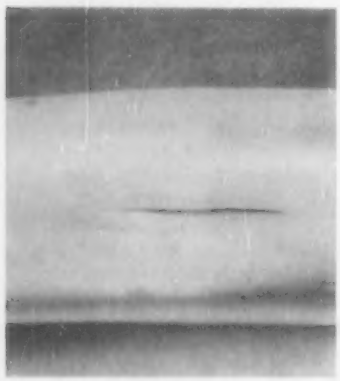
[1]VM&P naphtha of specific gravity 0.735 to 0.749; boiling range 194 to 248°F.

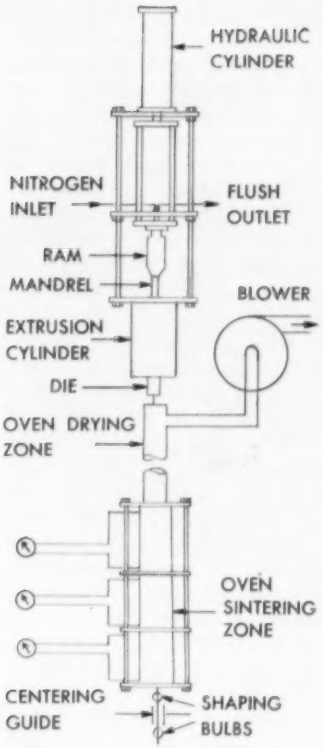
Teflon processing difficulties and their remedies

The sources and remedies for many common difficulties in the type of extrusion described in the accompanying article are outlined below. The list is not complete but the most frequently occurring operational errors are covered.

Description	Source	Remedy
"Fingernail" flaws	**a.** Powder sheared, overworked. **b.** Flash toward ram or between die and cylinder wall. **c.** Abrupt changes in flow direction and shear pattern.	**a.** Avoid smearing during handling. **b.** Check fit of O-rings. Check machined tolerances. **c.** Streamline the die approaches.
Blistering	**a.** Too high drying temperature. **b.** Entrapped moisture. **c.** Entrapped air.	**a.** Reduce extrusion rate or lower heating rate in evaporation zone of oven. **b.** Check powder for moisture. **c.** Check preforming operation.
 Internal splits partial	**a.** Insufficient deformation at mandrel. **b.** Temperature gradient across the extruded tube cross-section.	**a.** Reduce mandrel diameter above die land. **b.** Reduce velocity of nitrogen flush through inside of tube.
 Out of round	**a.** Too much tension during drying and sintering.	**a.** Decrease tension on take-off.
 Scarred surface	**a.** Dry spot in billet. **b.** Extruding below 66° F. transition temperature. **c.** High shearing of billet due to insufficient naphtha. **d.** Billets stored too long, causing loss of naphtha. **e.** Scratches or pits in die, cylinder, or mandrel.	**a.** Increase the naphtha content or more uniform compounding. **b.** Increase storage and operating temperatures. **c.** Check naphtha loss from billets or increase naphtha. **d.** Check storage in hermetically sealed containers. **e.** Check the surface mentioned. Light rust spots or pitting can be worked out with fine emery or honing.
 Dark gray color	**a.** Tubing overheated during sintering.	**a.** Reduce length of sintering zone or sintering zone temperature.

(*Continued on page* 118)

Description	Source	Remedy
 Excessive fibering	a. High shearing of billet due to insufficient naphtha. b. Billets stored too long, causing loss of naphtha. c. Scratches or pits in die, cylinder, or mandrel.	a. Check naphtha loss from billets or increase naphtha in recipe. b. Check storage in hermetically sealed containers. c. Check the surfaces mentioned. Light rust spots or pitting can be worked out with fine emery or honing.
Heavy dark or black splotches or streaks	a. Carbon residues due to grease and oil. b. Airborne lint or flecks from cotton gloves.	a. Check hydraulic system for leaking. Check naphtha for color-possibility of contamination. b. Check air-conditioning and use of cloths or cotton gloves.
Curling to one side and irregular flow including rippled extrudate	a. Uneven density in the preform. b. Partial evaporation of naphtha on one side of preform. c. Faulty centering at start of extrusion.	a. Check loading operation and preforming pressure. b. Check storage and handling of preforms. c. Check centering plug for trueness. If worn, replace with new one.
 Uneven wall thickness	a. Faulty centering start of extrusion.	a. Check centering plug for trueness. If worn, replace with a new one.
 Longitudinal splits	a. High shearing of billet due to insufficient naphtha. b. Billets stored too long, causing loss of naphtha. c. Hang-up of hard particles in die. d. Too high drying temperature. e. With small tubing (to ½" I.D.) excessive flexing. f. With larger tubing (1" I.D. and up), too much lateral movement in drying oven.	a. Check naphtha loss from billets or increase naphtha in recipe. b. Check storage in hermetically sealed containers. c. Examine die and mandrel for nicks or burrs. Check preforms for gross contamination. d. Check drying oven profile. e. Diameter of spool may be too small. f. Insert spacers to decrease motion.
Wavy, broken surface	a. Overworking powder before compounding.	a. Check powder handling procedures and screening techniques.



Basic equipment for extruding thin-wall tubing

a 1- or 5-gal. bottle, 20 min. at 15 r.p.m. is usually adequate. It is far more desirable, however, to store the sealed compounded stocks overnight to permit diffusion of the extrusion aid to the interior of individual particles and to any surfaces not reached in the rolling process.

The amount of extrusion aid to be incorporated varies with the liquid used and the extruder geometry. Generally, some experimentation will be required to determine the optimum in a given case but Table I may be used as a guide for naphtha.

Because naphtha is flammable, adequate precautions should be taken to avoid fire. Smoking in the area must be prohibited. Explosion-proof motors and switches should be used, and equipment subject to static discharge should be grounded.

Pigments may be added for identification purposes. Loadings up to 2% are adequate, and such quantities do not appreciably affect the properties of the extruded tetrafluoroethylene tubing. Inorganic oxides such as National Blue,[2] Chrome Yellow,[3] and Ti-Pure[3] will withstand sintering temperatures. A series of satisfactory colors is produced by Ferro Corp.[4] Monastral[5] and Lithosol[5] pigments are also suitable. Pigments may be added by slurrying in the extrusion aid before compounding, or by dry blending before the addition of the extrusion aid.

Preparation of preform

To prepare the preform, a quantity of the Teflon composition is compacted in a cylinder with a core rod. The dimensions should be such that the radial clearance between the preform and the walls of the extruder cylinder and mandrel is 20 to 30 mils. Any cylinder having a smooth surface such as a 63-microinch finish and capable of withstanding 300 p.s.i. pressure will be suitable. It should be at least 2¼ times as long as the preform to be made, since the volume ratio of the compounded Teflon powder to the preform is about 2.25:1.

A weighed quantity of the composition is poured into the cylinder with care to assure that the powder is evenly distributed around the mandrel. A good practice is to place a conical plug over the exposed top of the mandrel and pour the powder over the cone. This aids in providing uniform distribution of the powder.

After inserting the closure plug in the preform cylinder, pressure is applied to compact the preform. An automobile jack suitably mounted is adequate for small preforms but for preforms over 4 in. in diameter or more than 8 in. high, a pneumatic cylinder is more satisfactory. Pressure should be applied slowly to avoid excessive local shear stresses in the preform and to permit the escape of air from the stock. Pressure should be built up to about 100 to 300 p.s.i. on the stock over a period of about 3 min., half the total being attained in the first 2 minutes. In general, larger preforms require higher pressures. The peak pressure should be maintained for about ½ min. and the pressure slowly released. Great care should be used in pushing the preform out of the die to avoid breaking it or getting it dirty.

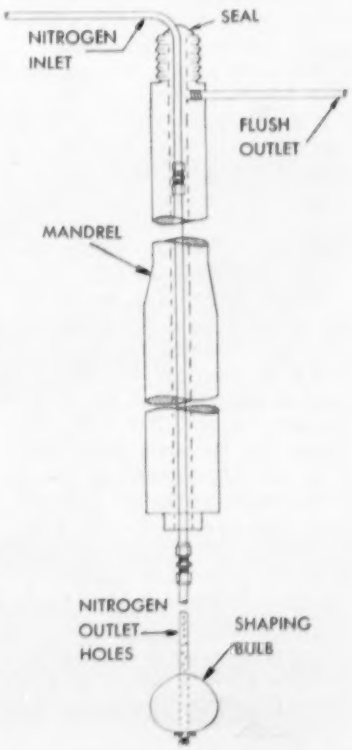
The preform is a dense, clay-like product which can be smeared between the fingers into a film. If naphtha is the extrusion aid used, preforms should either be made up only as required, or they should be stored in close-fitting sealed containers to minimize evaporation. Under normal conditions, enough naphtha may evaporate from an exposed preform in 5 min. to give serious trouble.

Extrusion equipment

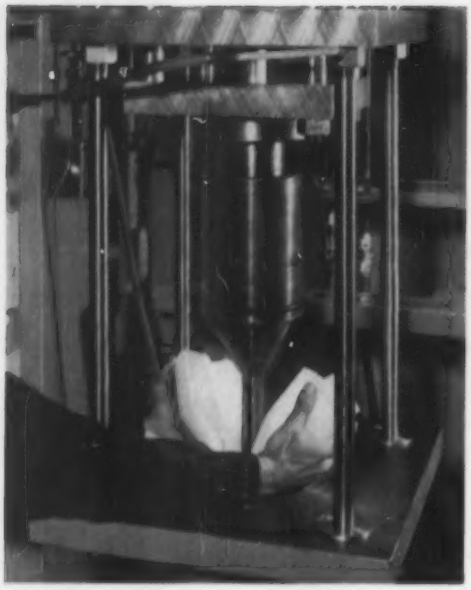
The basic equipment used for the extrusion of tubing from compounded Teflon tetrafluoroethylene resin consists of a ram, a mandrel over which the ram travels, a cylinder, and a die, all on a supporting frame. (See drawing, left.)

A hydraulic piston is preferred as a device for driving the ram, although a screw-jack has been successfully employed to drive

Close-up of mandrel forming bore of tubing



[2]No. 10034, B. F. Drakenfield, New York, N. Y.
[3]Chrome Yellow, medium Y-469-DR and Ti-Pure 510 titanium dioxide white, Du Pont Pigments Dept.
[4]4150 E. 56th St., Cleveland, Ohio.
[5]Monastral BFP and GFP and Lithosol 36D, RMM, and 4 RNL, Du Pont, Organic Chemicals Dept.



Cut preform of Teflon composition is loaded into extrusion cylinder preparatory to forming thin-wall tube

small-diameter rams. A single hydraulic unit can be used to power several extruders; the ram will stop without breaking any parts if excessive back-pressure should build up, and precision control of the extrusion pressure is possible. Equipment capable of providing 10,000 p.s.i. at the ram face should be adequate for most applications. The materials of construction for the extruder are not critical, but resistance to atmospheric corrosion is desirable.

For small tubing, the extruder may be either horizontal or vertical but for tubing more than 1 in. in diameter, a vertical machine is required. The mandrel forming the bore of the tubing can be straight or tapered (as in the drawing on p. 119) at the approach to the die land. The die is normally tapered from the diameter of the cylinder to the necessary size for the tubing to be made. A taper of 15° from the axis is recommended for small-diameter tubes; 30° from the center line for larger tubes (e.g., 1 in. I.D., 1.09 in. O.D.).

The length of the die land will vary, depending on the size of the extrudate. It should be long enough to prevent curling or swelling of the extruded piece and to provide the back-pressure necessary to produce a dense product. Table II lists recommendations for land length and die taper angle.

Heaters on the cylinder or die are not required for the extrusion of large tubing, since this can be done at room temperature. However, some reduction in extrusion pressure results from heating the die to 175 to 195° F. Thermostatic control is not essential.

Extrusion operation

The extrusion process is carried out batch-wise. The machine must be stopped after each preform has been extruded and the ram retracted to insert a new preform in the extrusion cylinder. The ends of the preform are conical; thus successive preforms can be nested without disturbing the remainder of the previous charge. In this way, unbroken lengths of tubing can be produced with a minimum risk of flaws. The preform is cut axially with a fine wire and re-assembled around the mandrel, but care must be taken to prevent the formation of bubbles or seams in the final tubing. It is good practice to cut the preform in a zig-zag pattern to aid in obtaining a good bond in the finished extrudate. Any skin of oriented stock formed along the cut by the drag of the cutting wire is easily removed and should be discarded.

In starting up an empty extruder, a tube 2 to 3 in. long and carefully machined to the proper size should be inserted in the die land from the discharge end of the die. It should be made to fit snugly and it serves to center the mandrel with respect to the die body. When the stock of resin flows into the annular die land, the stock itself holds the mandrel in a centered position and pushes the positioning tube or centering ring out of the die. The centering ring should be made of a resilient, non-scratching material such as Teflon itself. At the end of a run, several feet of tubing will be suspended through the oven. A small motor-driven variable speed pay-out winch should be installed just below the die so that the tubing can be cut off at the die, attached to the pay-out device, and passed through the oven at the proper rate, thus avoiding waste.

Extrusion pressure

The pressure required for extrusion will vary, depending on machine design and processing conditions. Relatively high pressures are required if the concentration of extrusion aid is low, if the taper angle of the die is relatively large, if the land below the orifice is long, and if the ratio of the cross-section of the pre-

Table II: Die taper and land length

Cylinder diameter	*Tubing size*		*Reduction ratio*	*Die taper*	*Land length*
	O.D.	*Wall*			
in.	*in.*	*in.*		*incl. angle, °*	*in.*
6	4	0.060	35	60	14
6	3	0.060	50	60	12
6	2	0.060	70	60	10
6	1	0.060	135	60	8
6	½	0.045	410	60	6
4	¼	0.030	600	30	4
4	⅛	0.030	1400	30	3

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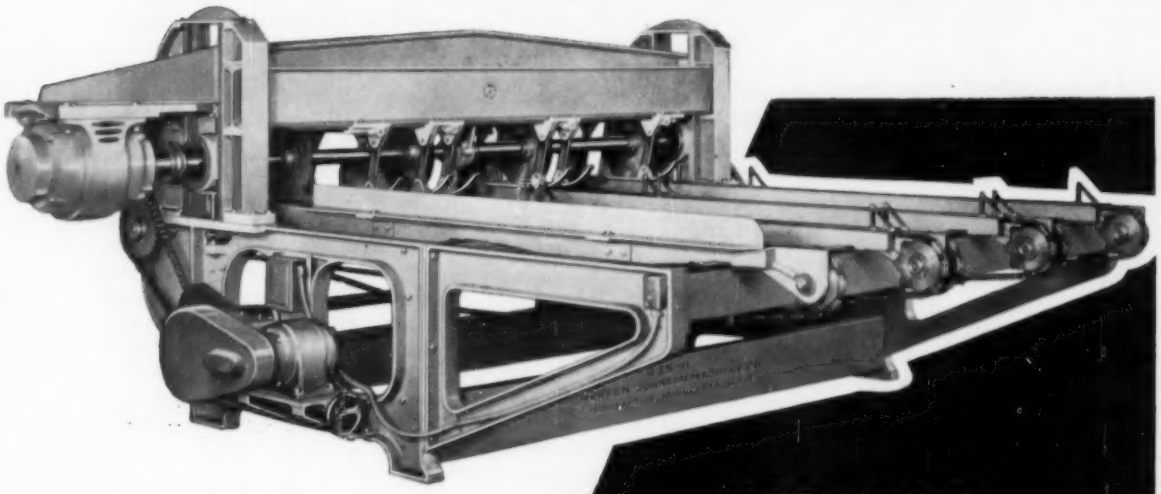

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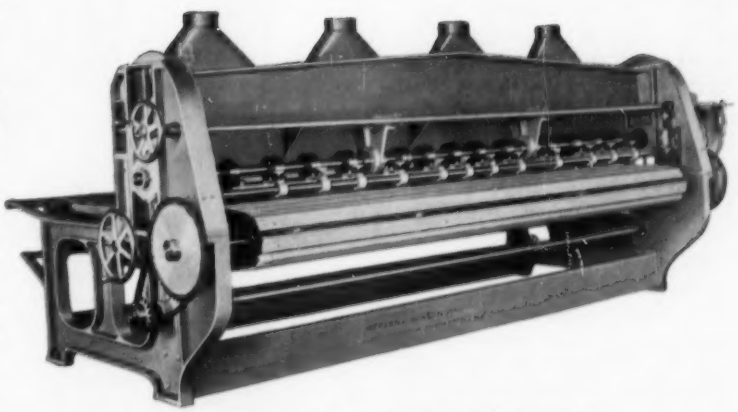

Rear View of 144x48 Slat Bed Machine

Mereen-Johnson **MACHINE COMPANY**

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Table III: Extrusion rates with 6-in. oven

Tubing O.D.	*Wall thickness*	*Rate*
in.	*in.*	*in./min.*
4	0.075	4
2	0.060	6
1	0.060	8
½	0.030	10
¼	0.030	10

form to that of the product (called the reduction ratio) is large.

If the pressure required is too high, the capacity of the machine may be taxed or the tubing may be excessively oriented so that it tends to develop longitudinal splits. If the extrudate is produced under too low an extrusion pressure, it may be weak and porous. This can be corrected by reducing the amount of extrusion aid used or by altering the die and cylinder geometry to increase back pressure.

The product as it leaves the extruder is not stiff. It is ductile and fairly strong in the longitudinal direction. Small sizes can be handled more or less readily without collapsing, splitting, or breaking. However, the major portion of the extrusion aid evaporates from the tube in a short time at room temperature, leaving a much weaker product. Consequently, the drying and sintering steps, whether batch-wise or continuous, should be carried out soon after the extrusion step.

Drying and sintering

The tubing, wet with extrusion aid, is processed in two steps. First, it is heated at a temperature sufficient to evaporate the extrusion aid. Initial oven temperatures only slightly higher than 200° F. are used for thick cross-sections, whereas temperatures up to 575° F. can be used for thin walls (such as 15 mils). Then the temperature is increased to well over 620° F. to sinter the tubing. The tubing temperature should reach 700 to 750° F. in the sintering zone. The total time the tubing remains molten varies with size. Two to 5 min. is sufficient for 2-in. diameter tubing with 0.060-in. wall thickness.

Removal of the volatile extrusion aid from the extrudate should be performed at a rate slow enough to prevent blistering. With naphtha as the extrusion aid, less than 5 min. is required for small tubing; up to 20 min. for 2-in. tubing with a 60-mil wall.

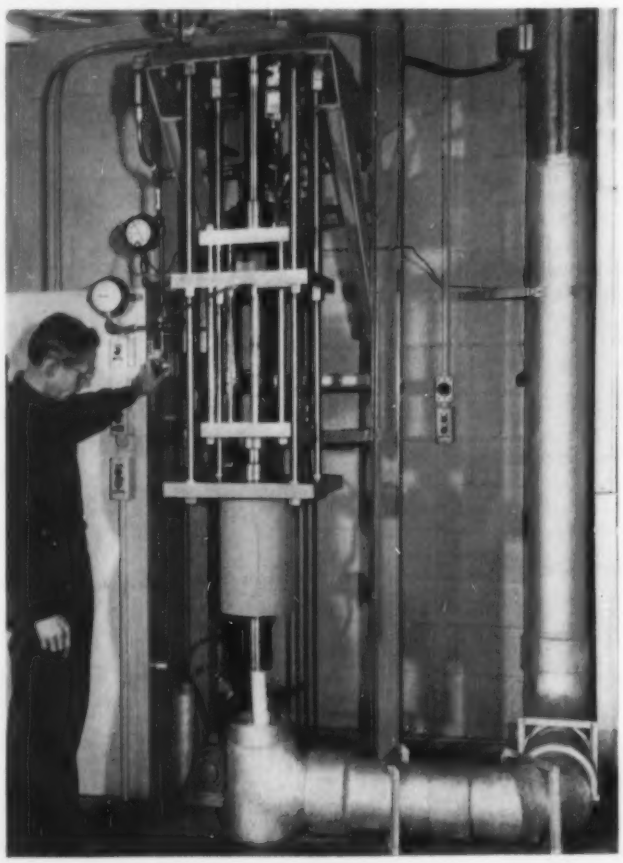
The additional heating time required for sintering is approximately the same as that required for volatilization when the heat source is hot air. The use of infra-red heat reduces the time substantially, e.g., 5 to 10 min. for 2-in. tubing with a 60-mil wall. The optimum time for any particular size is easily determined by a few experimental runs.

The volatilization and sintering operations should be carried out in such a manner that the resin is free to shrink or swell. Shrinkage is caused by a relaxation of stresses introduced during the extrusion, and by reduction in volume resulting from the removal of the extrusion aid. As much as 40% shrinkage, most of which occurs in the machine direction, may be experienced. Changes in wall thickness perpendicular to the axis of the tubing are very small, but the diameter will depend markedly on how quickly the sintered tubing is cooled. Slow cooling results in high shrinkage.

Infra-red heat

Considerable development work has been carried out on the use of infra-red heat in the sintering step. Teflon transmits some of the infra-red rays; consequently, the portion of the rays reaching the inner sections of the extrusion produces internal heating. This is more efficient than the conduction-convection heating obtained with hot air. The heat-transfer coefficient of the air film next to the Teflon is low, and tetrafluoroethylene resin conducts heat very slowly. When infra-red heat is

Thin-wall Teflon tubing extruder in operation. The tubing seen emerging at bottom is still to be sintered



illustrious label

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Information regarding Tenite also can be obtained from local representatives listed under "Plastics—Tenite" in the classified telephone directories of the following cities: Chicago, Cleveland, Dayton, Detroit, Houston, Leominster (Mass.), Los Angeles, New York City, Portland (Ore.), Rochester (N. Y.), St. Louis, San Francisco, Seattle and Toronto—elsewhere throughout the world, from Eastman Kodak Company affiliates and distributors.

Sintered tubing emerging from tubular oven located one floor below the extruder. (Photos and diagrams, Du Pont)

used, both the outer and inner sections reach the sintering temperature much more quickly. For 2-in. tubing an oven 6 in. in diameter with an over-all length of 10 ft. is suitable. All of the heat lower 5 ft. of the oven. By proper is radiated from the wall in the adjustment of the three heating zones and the air flow through the oven, a temperature profile in the evaporation zone suitable for proper drying can be attained.

An air supply of 50 standard cu. ft./lb. of stock extruded has been found satisfactory for a 6-in. diameter oven sintering 2-in. diameter tubing. A blower capable of displacing 200 to 300 cu. ft./min. under zero load conditions is adequate for most installations. The temperature should increase steadily from the top of the oven downward, starting at about 200° F. for a tube with a 60-mil wall thickness and reaching 575 to 600° F. at the top of the radiant heating zone. The nature of radiant heat makes the measurement of true temperature difficult, but in the zone where sintering occurs the material should be heated to 700 to 750° F.

The time the Teflon should remain in the "gel" (molten) state must be determined experimentally and depends partly on the degree of longitudinal orientation produced during extrusion. The major portion of this orientation must be destroyed so that the finished tubing will have adequate strength in the circumferential direction.

Extrusion rate

The rate of extrusion of tubing may be limited by the rate at which the extrusion aid can be evaporated. Evaporation rate is limited by the appearance of bubbles in the finished stock. Typical extrusion rates are summarized in Table III (p. 122) for an oven 6 in. in diameter.

The rate of cooling of tubing leaving the sintering zone of the oven has important effects on the physical properties listed in Table IV (p. 125). If the tubing is quickly cooled, either by quenching with water or cool air, the resultant stock will have low specific gravity; i.e., in the range 2.14 to 2.16. If the tubing is cooled slowly, the specific gravity of the products will be high; i.e., 2.20 to 2.22. Essentially all of the effect of cooling rate on specific gravity is confined to the temperature range of 625 to 575° F.

Tubing over about 1 in. in diameter tends to distort out of round during sintering and cooling. This can be minimized by suspending shaping bulbs from the end of the mandrel at a point just below the sintering zone. These bulbs should be smooth, round in cross-section, and ⅛ to 3/16 in. smaller than the inside diameter of the tubing. Because of a low coefficient of friction, and good corrosion and heat resistance, bulbs made of Teflon work well. Two bulbs about 10 in. apart are adequate.

In using naphtha or any other organic extrusion aid, care should be exercised in the oven design to minimize the fire hazard. Sufficient ventilation should be provided so that the concentration of naphtha remains below 0.9% (by volume). For tubing on the order of 1 in. diameter and larger, nitrogen should be flushed through the tubing via a suction system through the mandrel (see drawing, p. 119). By this technique, extrusion aid vapors are swept from the inside of the tubing. The nitrogen flow should be from 0.5 to 2.0 cu. ft./min. depending on tubing size.

In the laboratory, lengths of small-diameter tubing up to 100 ft. long have been extruded, coiled loosely, and later dried and sintered batch-wise in air ovens. In commercial operations an integrated process is more desirable for larger sizes. The minimum bending radius increases rapidly with tubing diameter above ¾-in.; substantial head room below the bottom of the oven thus becomes a necessity. Two-in. diameter tubing requires an estimated 8- to 10-ft. bending radius. For larger tubing it becomes advisable to provide head room below the oven sufficient for production of useful lengths without coiling.

Properties and uses

Typical properties of sintered tubing are given in Table IV for low, intermediate, relatively high

Table IV: Typical properties of thin-wall extruded Teflon tubing

Specific gravity	up to 2.14	2.16	2.19
Tensile strength, p.s.i. (ASTM D638-49T)			
longitudinal	4100	4000	2900
transverse	3900	3100	3000
Elongation, % (ASTM D638)			
longitudinal	435	350	560
transverse	450	440	560
Stiffness, p.s.i. (ASTM D747)			
longitudinal	49,000	69,000	82,000
transverse	45,000	67,000	90,000
Permeability to nitrogen g./mil/day/100 sq. in./atm.	1.2	0.59	0.16
Permeability to steam at 340° F. g./mil/day/100 sq. in./atm.	130	58	25
Weather resistance	unaffected		
Chemical resistance	attacked only by molten alkali, metals, and fluorine at elevated temperatures		
Moisture absorption	0.00		

levels of specific gravity. These properties—plus chemical inertness and the wide range of service temperatures inherent in Teflon—indicate that it should find general application in chemical plants and laboratories as process tubing and pipe lining. The high dielectric strength, low power factor and dielectric constant, and excellent heat resistance make it valuable as flexible sheathing for cables, as slip-on insulation for hookup wire, and as sleeving for resistors.

Reinforcing agents can be incorporated into the composition to increase strength and rigidity, although they also increase permeability and brittleness. In general, use of reinforcing agents in thin-wall tubing imposes more disadvantages than advantages. Some examples of these agents are asbestos, powdered glass, carbon black, metal powders, and inorganic oxides. In some cases, loadings as high as 25% by volume have been found to extrude satisfactorily. Higher extrusion pressures are needed for reinforced compositions and larger amounts of extrusion aid should be used to partially offset the higher pressure requirement.

Testing the product

Numerous tests may be suggested as production controls or possible use in establishing commercial standards. If the tubing has good appearance—that is, has a light gray color and is free from structural faults and contamination—the next most important criterion of quality is specific gravity. Tubing can be tailored to meet certain requirements and control over specific gravity is the key to this tailoring. For both chemical and electrical applications, freedom from microscopic pin holes is essential. The incidence of pin holes can be measured by inserting a grounded conductor into the tubing and scanning the outer surface with a high-voltage discharge device.

Inadequate sintering results in a product which is far stronger in the longitudinal direction than in the transverse. Adequately sintered tubing for most uses should have a tensile strength in the transverse direction at least 60 to 70% of that in the longitudinal direction.

In larger sizes, eccentricity beyond a reasonable level for use will generally result in a wrinkled, obviously useless product. Variability in wall thickness should not exceed ±6 to 7% of the nominal thickness. Flatness or out-of-round is relatively unimportant in tubing intended for pipe lining if the circumference is held within acceptable limits. In the smaller sizes more widely used for reinforced hose constructions, roundness is easier to attain, and even the oval cross-section produced in coiling is not serious.

Contamination by gross particles of foreign matter should be minimized. Tubing produced by this process has a characteristic over-all gray color unless pigmented. There is no indication that a medium gray color is detrimental to any property of the tubing.

Health hazards

Animal tests have clearly shown that Teflon tetrafluoroethylene resin produces no skin irritation, and has no toxic effect when taken internally. These laboratory tests are substantiated by the fact that no such cases arising from the handling of the polymer are known to the Du Pont Co.

Because of its excellent physical properties at high temperatures, Teflon may be used continuously at 500° F., or intermittently up to its melting point, 620° F. When heated above 400° F. (204° C.), however, small quantities of gaseous decomposition products are evolved. Some of these gases are toxic and must be eliminated by adequate ventilation. The use of proper ventilation is so effective that very few cases of ill effects from exposure to the volatile products of Teflon have been encountered.

For detailed information on toxicology, see Du Pont Polychemicals Dept. Information Bul. No. X-59.

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Plastics Technical Section

Dr. Gordon M. Kline, Technical Editor

Electrostatic charges in plastics

*By Selby M. Skinner,† Joseph Gaynor,‡ and George W. Sohl***

Experimental evidence is presented that the "static" charge on plastics is a volume charge distribution rather than a surface distribution. The charge contained in a plastic that has been in contact with metal is found to drain out of the plastic by a flow process which depends both upon the resistivity of the plastic and upon the possibility of neutralization of surface charges by opposite charges external to the plastic such as in air. Flow patterns similar to those resulting from several sources of fluid flow are observed when holes are torn in the surface of the plastic during break of an adhesive sample.

The observations are confirmed by the transfer of charges in frictional sliding of plastics on metals. Charging proportional to the weight of plastic slid, and transfer of plastic to the metal also proportional to the total amount slid are observed.

Practical applications to the control of static charges on polymers and to adhesion technology are indicated.

A fairly extensive literature deals with the electrical charges that are found on insulating materials such as plastics, paper, rubber, glass, and synthetic fibers. Most of the articles deal with the undesirable effects of charges, such as explosion hazard, problems with dust collection, handling difficulties with textiles which necessitate the use of destaticizers or size, electrical fields in small radio parts, or even the graying produced in commercial laundering and its relation to the static charge between the cleaning fluid and the white article. Some articles consider the nature of the charge. The explanations usually advanced have attributed the observed effects to a charge located soley on the insulator surface. It is the purpose of this article to present evidence that the charge is a volume distribution within the plastic, to discuss its behavior, and to bring out some practical implications, but not to rule out or minimize the effects of surface and their corresponding energies which most certainly contribute to these and other phenomena as well.

Woodland and Ziegler (1)[1] have described an extensive investigation of static charges on thermoplastic wall tile as related to the dust-collecting properties of the tile. One of their conclusions was that the charge appeared on the tile only in those areas that had been in contact with metal during molding. They also related the likelihood of observing charge on a plastic to its surface resistivity, since greater resistivity implied a longer time for any charge on the plastic to leak off. Actual measurements made in our own laboratory on the charges that result when a metal-high polymer adhesive-metal sample is broken in tension show that the charge persists for periods of months, and cannot be permanently removed within any short period of time by surface treatment alone. The inefficacy of destaticizers applied to a

This research was supported by the Aeronautical Research Laboratory, Wright Air Development Center, U. S. Air Force. The sliding experiments were supported in part by the Office of Ordnance Research, U. S. Army. A portion of the contents of this paper was presented at the Symposium on Adhesion of the 50th Anniversary Meeting of the American Society of Mechanical Engineers in Boston, June 1955, and at the Gordon Research Conference on Adhesion, A.A.A.S., New Hampton, New Hampshire, August-September 1955.

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[1]Numbers in parentheses link to references at end of article, p. 246.

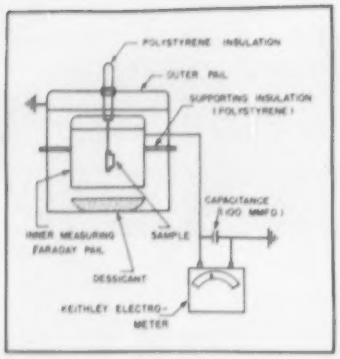

Fig. 1: Faraday ice pail and electrometer for measuring the charge on samples after break

plastic material after washing of the plastic, was mentioned in reference 1.

Charges on commercial plastics

Although it is not commonly recognized, almost any manufactured plastic article purchased in the open market will be electrostatically charged, even months or a few years after its production. The more electrically resistant plastics, especially, such as polyethylene, polystyrene, Teflon, and polymethyl methacrylate, exhibit this behavior. An ordinary polyethylene funnel or drinking glass brought near an electrometer will cause large deflections. Using a Keithley electrometer, connected as in Fig. 1, above, measurements have been made on commercially obtained bulk plastic, and on sheet, film, and powders of various plastics. A typical distribution, in order of increasing charge, obtained in such qualitative experiments is given in Table I, below.

Recently, one of the authors (2) has shown that modern concepts of solid state theory and steady state thermodynamics predict that at the contact between a metal and an insulating material, such as a plastic, thermodynamic equilibrium requires a transfer of charge into the plastic. Basic to the theory is the assumption that in insulators just as in semiconductors, the electrons are subject both to the electrical field and to diffusion. When an insulator such as a plastic is in direct contact with a metal, charge diffuses from the metal into the plastic, producing a volume space charge which is maintained in diffusion equilibrium. The total amount of charge that has entered the plastic becomes rapidly larger with increasing temperature. At molding temperatures, the amount of charge can be quite large. The metal is left with an opposite charge of equal amount, which, because it is a metal, is located on its surface.

Because charges diffusing into the plastic must overcome the repulsion of those that previously entered it, the total charge in the insulator is limited. The further into the plastic the charge goes, the greater is the space charge it has to pass; therefore, fewer charges are able to penetrate deep into the interior than can reach regions nearer the boundary. The space charge within the plastic decreases with distance from the contact with the metal. If a large amount of charge has entered the plastic, this decrease is extremely rapid, but with a smaller amount of total charge, the decrease is much more gradual. The charge density is plotted as a function of distance from the boundary in Fig. 2, p. 129.

Electrostatic component of adhesion between metal and plastic

Obviously a negatively charged plastic in contact with a positively charged metal will be attracted to it by electrostatic forces. In order to remove the plastic from the metal it is necessary to overcome, among other forces, this electrostatic component of adhesion. Therefore, such electrostatic attraction constitutes a part of the force which acts to oppose removal of the plastic material from the mold.

When a piece of plastic is placed against a piece of metal, there is not complete contact. Surface irregularities in both, and surface contamination on either (including oxide or other films on the metal), prevent perfect uniform contact. It can be shown that at regions not in contact the barrier to charge transfer becomes so great that only infinitesimal amounts of charge pass through the interface. At regions of impurity, the barrier is not so great, but nevertheless, the effect is a greater or lesser decrease in the amount of charge transferable. For the present purpose, it is possible to assume that charge transfer takes place only at the areas of contact.

In a properly prepared adhesive bond a maximum area of contact is achieved, and therefore the charge transfer should be observable at break. Such charges have been observed (3, 4, 5) and correlated with the breaking strength of the adhesive bond (4, 6). However, since there are other conceivable mechanisms for the electrical charges observed, a number of experiments have been performed by us to check the predictions in references 2, 4, and 6. Those experiments directly applicable to the electrostatic charging are reported here. They exhibit points of fundamental interest, and have implications for practical adhesives and plastics technology. The behavior of tensile strength and

Table I: Charges observed on plastics

Negative Charge	*Positive Charge*
Rigid vinyl	Soft polyester
Polystyrene	Cellulose acetate
Polyethylene	Saran
Teflon	Plasticized vinyl
	Cast phenol-formaldehyde
	Molded phenol-formaldehyde
	Polytrifluoromonochloroethylene
	Polymethyl methacrylate
	Cellulose acetate butyrate
	Nylon
	Glass-fiber-filled polyester

NOTE: Both positive and negative charges are distributed on the polymeric surface when it is obtained. The order given above is that of the net resulting charge for the specimens used. Actual values, and sometimes even the sign of the charge, on commercially obtained materials has been found to depend upon the preparational and subsequent history. No such ambiguity exists in the measurements reported in tables that follow.

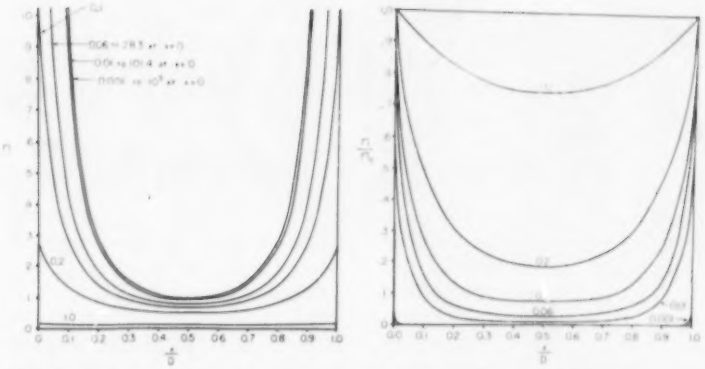

Fig. 2: Charge density in a polymer adhesive between two identical metal plates. Graph at left shows actual density, n. Graph at right shows charge density relative to that at the metal interface, n/n_o. The metal plates are at $x = O$ and $x = D$, and the charge density is shown as a function of distance from one plate. Different curves show the distribution resulting when different amounts of the total charge have entered the polymer. The smaller the parameter by each of the curves, the larger the amount of electrostatic charge in the adhesive

its relation to the observed charge will be reported elsewhere (6).

Polymer charge immediately after separation from a metal

Before break the sample is not charged, as is shown by inserting it into the Faraday ice pail shown in Fig. 1; any charge on the sample appears on the outer surface of the inner pail and produces a potential between the two pails. No such potential is observed before break. The uncharged sample is placed into the tensile machine and stress is applied until the sample is broken.

Figure 3 (below) is a schematic representation of the adhesion sample and its electrical connection during stressing and break. No external source of potential is in the circuit. The oscilloscope has a trigger circuit so that no trace appears until a signal is received.

During the period of approximately a minute during which stress is being applied before break, no signal occurs on the oscilloscope face. At break a transient potential such as shown in Fig. 4 (below) appears and lasts for a time of the order of milliseconds. The transient can occur only if the two halves of the sample are electrically charged. In fact, when the adhesive is stripped entirely from one metal surface, the area under the trace is proportional to the charge on the plastic, and the sign of the charge determines whether the trace is above or below the line. The existence of charge, therefore, is demonstrated by the oscilloscope voltage trace, the sign of the charge by the direction of the y deflection, and the amount of charge by the area under the trace[2].

In the experiments reported here, the adhesive was always polymethyl methacrylate and the adherends were copper or aluminum; other polymers and plastics have shown similar behavior. The charge in the plastic was negative in all cases, as indicated by the trace on the oscilloscope. Its order of magnitude for a 1-sq. in. plastic film about 10^{-2} to 10^{-3} in. thick was from 10^{-7} to 10^{-9} coulombs. However, the charge measured on either half of the sample after break by the Faraday ice pail (Fig. 1) was usually considerably less than that indicated by the oscillograph trace; the sign of the charge as measured by the ice pail was not always negative. Apparently, ions from the atmosphere were deposited on the plastic surface within a very short time after break, partially neutralizing the original charge on it. Atmospheric ions are plentiful during a corona discharge, and would be drawn to the surfaces by the electric field in the discharge.

In order to study this effect, charged fluorescent powders were obtained, similar to those used in reference 1, and mixtures of op-

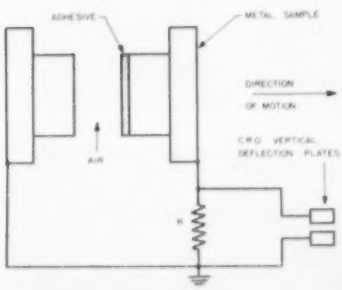

Fig. 3: Electrical connections on metal samples for measuring the charge at break. The two halves of the sample are shown schematically immediately after break

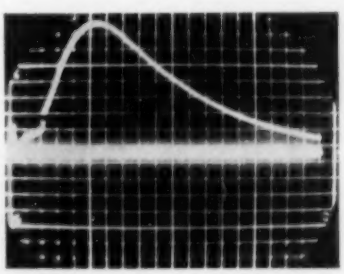

Fig. 4: Transient potential on oscilloscope face at break of adhesion sample

[2]The amount of charge is the charge that passed through the resistance R, i.e., through the external circuit. This is not the total charge that originally flowed into the plastic from one metal at the metal-plastic boundary, for a number of reasons, of which two are especially important. The first is that, during the break, the electric field in the air between the plastic and the metal increases to the point at which the air breaks down and becomes conducting; the resulting corona discharge neutralizes much of the original charge on the plastic without the passage of charge through the external circuit. The second is that if a portion of the metal is torn out and remains with the plastic, the charge that was originally transferred from that metal is not measured because charges of both signs are present and neutralize each other; similarly, if a portion of the plastic remains on the metal, a portion of the charge in the plastic originally transferred through that area is not measured. The corona discharge could often be heard and at times seen.

positely charged powders were blown from a DeVilbiss dust atomizer over the samples at varying times after break. The dusting was performed before touching the buttons. Since each powder goes to regions on the metal or plastic that are charged oppositely to it, it helps keep the charge in place. The charge on the plastic is also bound by the opposite charges on the metal button behind it; these originally came to the button from the opposite button by flow through the resistance in the external circuit. However, lateral repulsion between charges remains.

From the patterns obtained with successive samples sprayed at different times after break, there emerges a pictorial history of the probable behavior of the charge in the plastic after break. This has been put together from the behavior of a number of individual specimens, but the types of effects have been observed with a sufficient number of repetitive cases so that the general nature of the behavior is clear.

Just before break, the adhesive is negatively charged, as is shown by the direction of the oscillograph trace during break. A counterbalancing positive charge is pulled away with the metal, and a strong field arises in the air, producing positive ions, which deposit on the negatively charged plastic surface. The avalanche produced by the corona discharge deposits enough positive ions on the surface so that it becomes positive. The existence of a relatively uniform layer of positives on the surface of the plastic is shown by the green color in Fig. 5 below; the green and/or yellow powder deposits on positive regions.[3] The sum of the

[3]The powders used were fluorescent powders manufactured by Imperial Paper & Color Corp., Pigment Color Div., Glens Falls, New York.

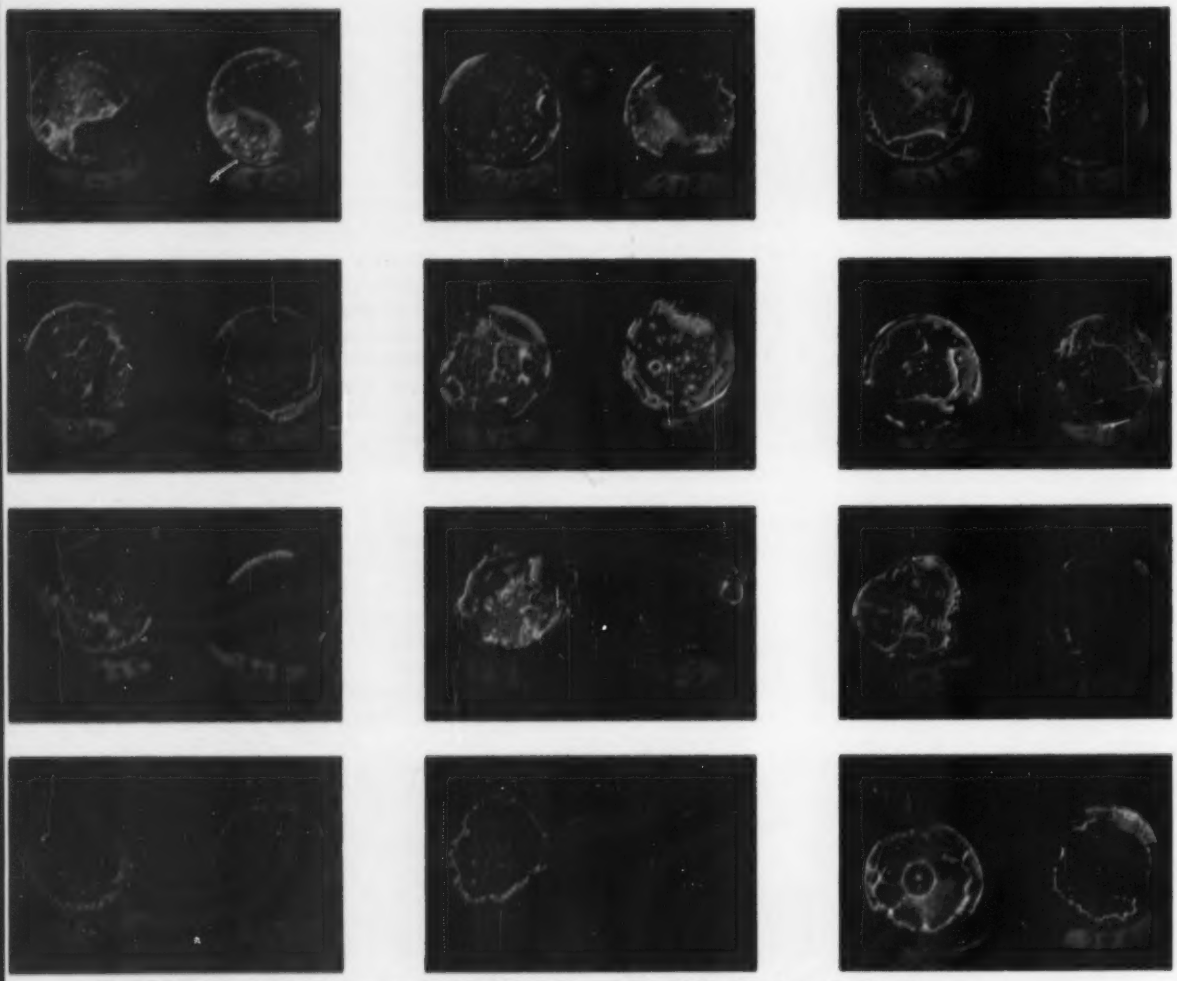

Fig. 5: Charge distribution on the surface of broken sample at different times after break. Red represents negatively charged areas, yellow and/or green represents positively charged areas. Note especially the left-hand sample in each case. The pairs of adhesion samples at times after break as indicated are, left to right and top to bottom: aluminum-polymethyl methacrylate (7, 15, 45, 60, 90, 120, and 150 sec.); copper-polymethyl methacrylate (2 to 3 and 180 sec.); copper-polymethyl methacrylate (20 and 90 sec.); and aluminum-polymethyl methacrylate with greater prepolymerization at 360 sec. after break

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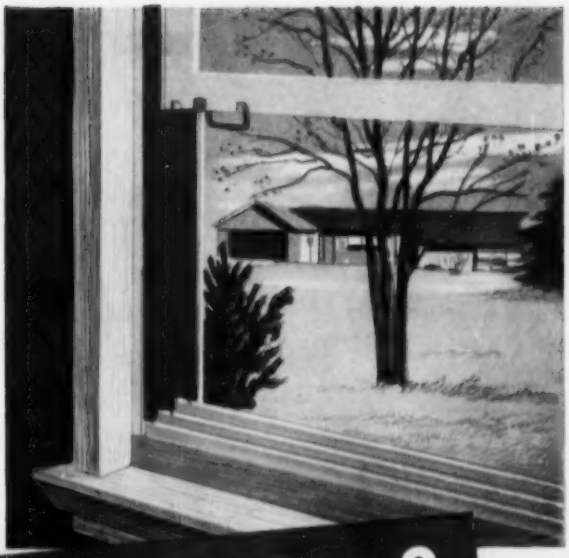

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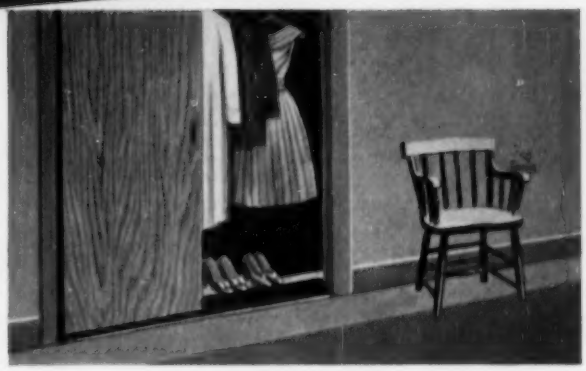

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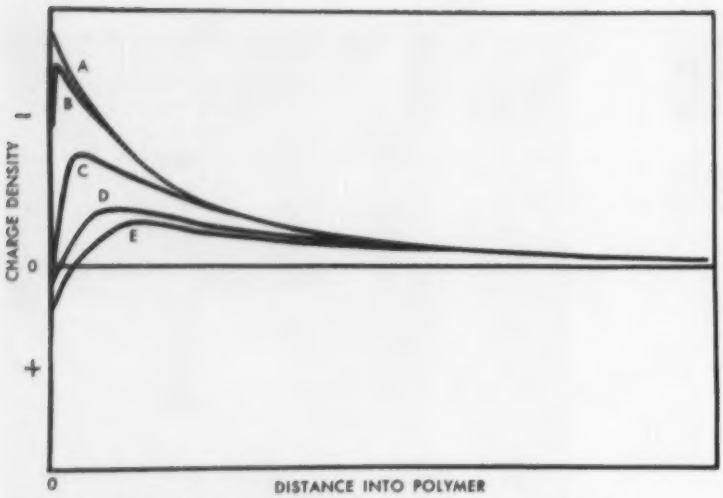

Fig. 6: Schematic charge density in polymer volume as a function of depth in polymer and time after break. Successive curves from curve *A* down represent successive steps in timewise behavior

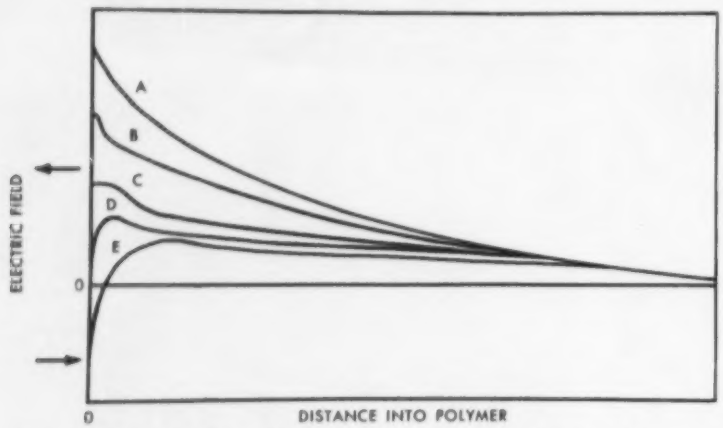

Fig. 7: Schematic electric field in polymer volume as a function of depth in polymer and time after break. Portion of curve above zero line represents electric field impelling negative charges toward the interface, that below impelling them into the plastic

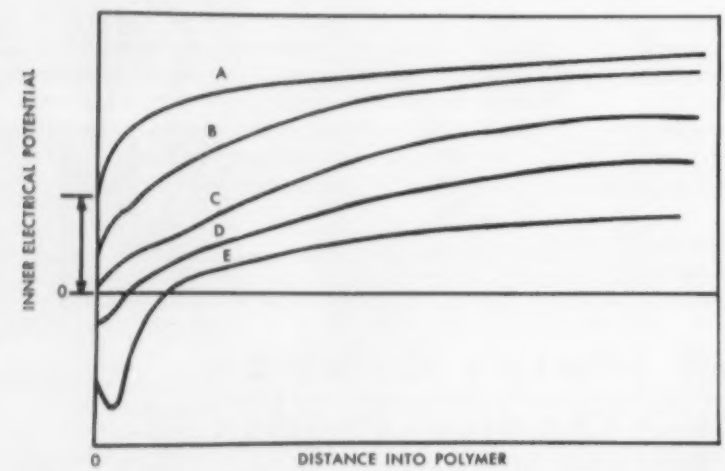

Fig. 8: Schematic inner electrical potential as a function of depth in the polymer and of time after break

volume plus surface charge is, however, negative, as shown by the Faraday ice-pail measurements of the unpowdered sample.

Accordingly, it may be assumed tentatively that, both before break and immediately afterwards, the charge density, field, and electrical potential in the plastic are as shown schematically in curves *A* of Figs. 6, 7, and 8, left, i.e., the top curves; a counterbalancing positive charge on the surface of the metal is pulled away with it to "infinity," leaving a nonequilibrium concentration in the plastic. In curve *B* of the figures, there is shown schematically the situation when only a few ions have deposited during the corona discharge; curves *C*, *D*, and *E* show the successive events resulting in a positive surface charge but a negative total volume and surface charge. Subsequent events are of interest, as the nonequilibrium distribution approaches equilibrium.

As would be expected, the figures show a flow of the positive surface charge across the surface to the edge and thence presumably over the side to the metal. This flow is aided by the lateral repulsion of the positives on the surface, and by the image charges on the metal, and continues until the charges are neutralized or become bound. Up to a point surface flow can discharge accumulated charge.

On the other hand, if the original negative charge in the plastic had been entirely on the surface, it would be expected that the surface leakage to the metal would take place only until the surface became neutral. Actually it appears to continue past this point and the surface becomes negative again (see curve *C*, Fig. 6). To explain this, the behavior of the contained negative volume charge must be considered.

Immediately after break and corona charging of the surface, there is a distribution of charge consisting of positive surface charge and negative space charge within the volume of the plastic. This produces an electric field impelling the contained charge towards the surface. It travels there in accordance with the resistivity of the plastic, gradually

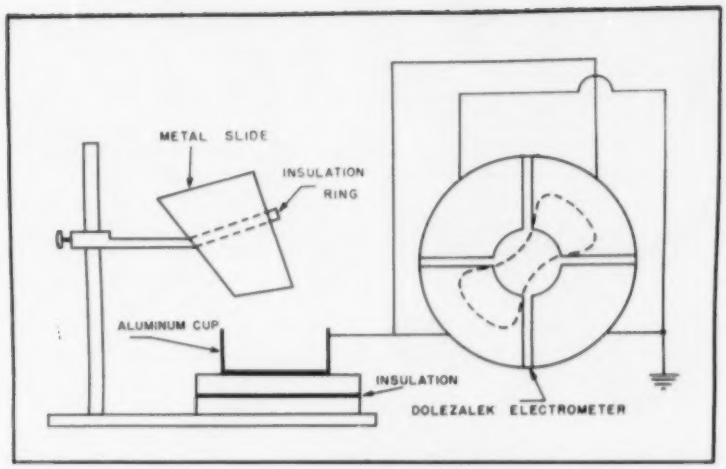

Fig. 9: Experimental arrangement for measuring charge transfer between metal and plastic powder during sliding

neutralizing the excess adsorbed charge; this flow continues even after the surface is neutral because of the repulsion of the negative charges, and eventually makes the surface somewhat negative. The fact that it can become negative indicates that after the corona discharge has ceased, and only small surface fields exist, ionic deposition from the air occurs to a much smaller extent. When the surface becomes negative, there is a slow deposition of positive charge onto it again from the air, and depending upon the rates of diffusion of volume charge towards the surface and of deposition of ions, this may or may not eventually render the surface positive again. The process may be repeated, but eventually equilibrium is attained.

Effect of inhomogeneous break

The simple picture just described applies to a uniformly smooth surface. In the actual case, it was found that little islands of polymer had been pulled out from the plastic surface and adhered to the button, which was otherwise stripped of plastic. The corresponding holes in the plastic seem to act as sources of negative charge, as may be seen in the figures.

Since the holes extend below the surface, it is more difficult for positive ions from the air to pass the charged surface and penetrate down into such holes than it is for them to go to the surface. The inner area of the holes will not be neutralized in the same way as is the smooth surface of the plastic. Negative charge is continually diffusing from the volume of the polymer toward the holes at any depth, and lodges on the inner surface areas of the holes. This charge is again subject to mutual repulsion and flows out onto the main plastic surface along the walls of the hole. The charge density is greater in the hole than on the surface even when the surface is negative, and, therefore, flow out of the hole is continuous; it is, of course, greater when the surface is positively charged than when it is negatively charged.

That portion of the negative charge contained in the polymer which escapes through the holes does not have to travel through the plastic to the surface, and is subject to surface rather than volume resistivity considerations. It may be thought of as having been drained prematurely. Therefore, the regions around the holes approach equilibrium somewhat sooner than do the regions farther from the holes.

If a number of holes are present, the outward flow from each continues until it reaches a similar flow from another, and the pattern is reminiscent of the fluid flow from several sources, the boundaries of charge advancing with due regard to all charges over the surface. The sequence of events is shown in Fig. 5.

When a piece of plastic is withdrawn from a mold, approximately the same events will occur; the initial positive charging of the surface will be more rapid, since there are no induced charges on a second piece of metal nearby, to partially neutralize the volume charge.

The subsequent gradual discharge of the plastic is therefore a draining process, and since the charges must come from the interior, will be dependent upon the resistivity of the plastic, as stated in reference 1. The volume resistivity as well as the surface resistivity is involved, and the charge drains toward both surfaces. Any subsequent accidental triboelectric contact, whether by dust particle, by rubbing, or otherwise, can impart additional charge to the plastic; some of this will diffuse inward, and a random overlay of charge will occur.

Frictional contact between metal and plastic

Charges are also transferred to insulating substances by frictional contact with other materials.

If a significant portion of the

Table II: Charges transferred to plastics sliding down metal surfaces

Metal of slide	*Plastic*	*Charge in coulombs per gram of polymer slid down*
Tinplate on steel	Polyvinyl chloride	7.52×10^{-8}
	Polyvinyl alcohol	1.07×10^{-8}
	Melamine-formaldehyde	4.00×10^{-9}
Aluminum	Polyvinyl chloride	9.6×10^{-8}
	Polyvinyl alcohol	4.8×10^{-9}
	Melamine-formaldehyde	1.92×10^{-8}
	Cellulose acetate	1.6×10^{-9}

adhesive force in tensile break of a specimen is due to the electrostatic component of adhesion, it would be expected that some correlation would be noted between the charges received by plastics and metals in frictional contact, and observed tensile strength in adhesive bonds between these materials. In performing such an experiment, the experimental conditions to be used must be considered carefully. If the usual wild variables encountered in electrostatic experimentation are to be completely avoided, there should be used vacuum techniques and all the apparatus of fundamental physics. On the other hand, since the results will be compared with those on tensile specimens, and the practical value of adhesion tests is directly related to the fact that they are performed under atmospheric pressure, varying humidity, and careful industrial techniques but not elaborate surface chemistry precautions, it is desirable that the tests be performed under conditions not too far removed from practice. Therefore, elaborate care was taken in preparation of the tensile specimens used in the experiments described in the previous sections, but they were broken in a tensile machine under essentially A.S.T.M. conditions in air at 73° F. and a relative humidity, adjustable within the range 30 to 50 percent. The sliding experiments were performed under similar conditions.

In the literature, it has been assumed that the rubbing process is responsible for such charging, i.e., that layers of contaminated or chemically reacted material are scoured from the surface, and then frictional energy manifests itself as electrical charge. Gonsalvez (7) describes the general view at the present time to be that the major factor is the contact between dissimilar materials rather than the rubbing. The question is discussed in greater detail by Henry (8). Compared to the diffusion equilibrium that has just been considered, frictional contact for a short period of time will be characterized by two contradictory tendencies. It will not permit sufficient time for establishment of diffusion equilibrium, but it will result in an increased temperature which favors greater charge transfer. Without going into the details, it is nevertheless evident that in the frictional contact between metal and plastic, qualitatively the effects will be similar to those discussed above, and a charge transfer into the plastic will occur. The frictional contact between plastics and metals offers, therefore, a method of investigating charge transfer between them.

Figure 9, p. 133, shows the experimental arrangement. Powders were slid down the slide into the cup, and a Dolezalek electrometer, connected idiostatically, measured the charge accumulating there. The plastic powders were stored in desiccators for 72 hr. before use. The slides, of copper, aluminum, and tinplate on steel, were acid cleaned, washed several times ending in distilled water, dried, and stored in desiccators until used. Before each measurement, all metal was cleaned and grounded, and the insulation of the slide and cup (polymethyl methacrylate, glass, and/or beeswax) was checked for charge accumulation.

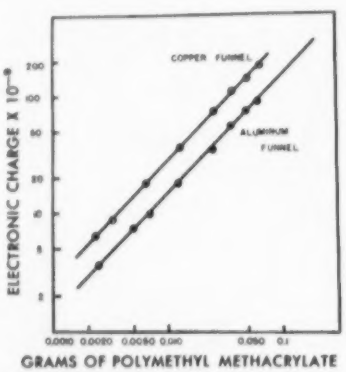

Fig. 10: Plot of electronic charge transfer during sliding of polymethyl methacrylate on copper and aluminum

In the initial experiments, considerable pains and experience were necessary to overcome the variables that produced random behavior. After this had been accomplished, linear plots (on a log-log scale) were obtained. The major observed factor responsible for erratic behavior was gradual charging of the insulation supporting the cup or the slide. Temperature and humidity affected the readings predictably. In the early stages it was found that the charge transferred to the metal per unit mass of polymer slid down decreased as the number of times sliding had occurred was increased. The adherence of a nonvisible layer of polymer to the slide as a result of previous sliding was suspected; electron photomicrographs at glancing angle scattering confirmed its existence by the effect of the charging of the film when bombarded with electrons. Thereafter, either fresh metal slides, or the same ones reproducibly cleaned with solvent after each run, were used for successive measurements. The mass of adhering material was determined by Soxhlet extraction; a sensitive method of measuring very low polymer concentrations was developed for this purpose and is described elsewhere (9).

The initial results of sliding plastics down metal slides gave log-log plots with slopes of 45°, indicating a directly proportional dependence of charge transferred on the mass slid down[4]. Initial results for a number of plastics are given in Table II. The measurements required considerable painstaking preparation, but after all parameters were suitably controlled, reproducible results were obtainable with the same batch of powder.

After the data presented in Table II were obtained, it was found that the powders were charged even before sliding, and therefore the initial charge per gram was measured separately and subtracted from the charge per gram found after sliding. The results of these experiments are shown in Fig. 10 above. Again it is found that the log-log plots have a slope of 45°, indicating a proportionality in the relationship between corrected charge transferred and mass slid down. The same proportionality was found for the weight of polymer adhering to the metal after sliding as a

[4]The particle size distribution, microscopically determined, was highly peaked at one size, with no discernible fines in the mixture.

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Table III: Corrected values of charge imparted to plastics by sliding down metal surfaces

Plastic	*Metal slide*	*K (electronic charges per gram)*
Bakelite	Tinplate on steel	5.67×10^{10}
(Phenol-formaldehyde)	None	3.80×10^{10}
	Net	1.87×10^{10}
Resinox	Tinplate on steel	2.04×10^{11}
(Phenol-formaldehyde)	None	1.95×10^{11}
	Net	9×10^{9}
Lucite	Copper	7.10×10^{11}
(Polymethyl methacrylate)	None	3.30×10^{11}
	Net	3.80×10^{11}
	Aluminum	5.12×10^{11}
	None	3.80×10^{11}
	Net	1.32×10^{11}

function of the weight slid down (9). Since there were no observable fines in the polymer powder, it seems likely that the adhering polymer was transferred from the sliding particles by wear during sliding. As a test, some radioactive polystyrene was made by emulsion polymerization, and the particles slid down a copper slide. A photographic film placed over the slide in firm contact showed, upon development, an even distribution of darkening, with no discernible evidence of graininess.

Using the linear relationship mentioned above,

$$Q = KM$$

where Q is electronic charges and M is grams slid down the metal, K has the values given in Table III above.

By combining the linear relationships, there results

$$Q = k_1 M_1$$

in which M_1 is the mass of polymer retained on the slide, and Q is that portion of the charge transferred to the metal as a direct result of the sliding (i.e., corrected for the original charge on the polymer which was carried over with the retained polymer.) The values of k_1 are given in Table IV below.

The values of k_1 and of K will depend upon the distance slid by the powder. In the experiments, this was 3½ inches. However, it appears likely that other distances, if not too small or too great, will give similar relative values as between different metal-plastic combinations for either of the constants k_1 or K.

It is reported in the literature (10) that polymethyl methacrylate is a better adhesive for metals than is phenol-formaldehyde. Further, results of the present work indicate that the bond strengths (under tensile test) of polymethyl methacrylate and copper are much higher than those for polymethyl methacrylate and aluminum. It will be noted in Tables III and IV that the constants K and k_1 for copper-Lucite>aluminum-Lucite >Bakelite-tinplate>Resinox-tinplate. While not conclusive, this agrees with the results of the tensile experiments. If a correspondence exists between the degree of adhesion and the charge acquired per gram of polymer in sliding, for a specific metal-polymer system, then the electrostatic mechanism for the component of adhesion receives support. Also, if performed with sufficient care, experiments on charge transfer during sliding of proposed polymeric adhesive combinations offer promise as a non-destructive method of investigating the suitability of such adhesive-metal combinations. To confirm this would require correlation of a variety of polymeric adhesive and metal combinations in both types of experiment.

Conclusions

1. The electrical charge transferred to a plastic during molding is indicated to be a volume rather than a surface charge. Its timewise behavior as it drains out of the plastic can be shown.

2. From the fundamental point of view, the pictures of the behavior of charge after break of an adhesive specimen are of interest. They support the volume charge hypothesis.

3. The ineffectiveness of including radioactive isotopes, or applying them or their radiations to the surface, or of including polymer-wettable metal powders in the plastic, in order to decrease the static charge, receives explanation in terms of the volume charge distribution.

4. The long periods of time during which polymers remain charged, and the correlation of such behavior with the resistivity of the plastic, are explained in terms of the diffusion of charge through the plastic.

5. The initial effectiveness of destaticizers, and the reappearance of charge when the destaticizer is removed, are due to the limited depth of penetration of destaticizer action. Most destaticizers act by increasing the moisture content on the surface. Since the high electrically resistant plastics are generally hydrophobic, this water stays essentially on the surface. Washing or otherwise removing these destaticizers leaves the unneutralized volume charge evident, although a portion of this charge will have been neutralized in the vicinity of the surface. Wiping off the destaticizer can add charge.

6. To obtain effective destaticizer action, a material is required that will penetrate into the volume of the plastic, render

(*To page* 246)

Table IV: Values of k_1 factor (see text above)

Metal	*Polymer*	k_1 *(no. of electronic charges per gram)*
Copper	Polymethyl methacrylate	2.75×10^{12}
Aluminum	Polymethyl methacrylate	1.47×10^{12}

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Phenolic resin process design

By F. W. Hammesfahr, D. C. Johnson,* S. N. Johnson,* and S. Seltzer**

The characteristics of a resol resin, namely, melt, grindability, viscosity, caking time, and flow point, are all related to stroke cure and water content for resins of normal advancement. Stroke cure can be predicted from the process cycle conditions and a nominal amount of laboratory data. Such predictions appear valid over large changes in scale of operation or operating conditions, thus making them very useful in both factory process engineering and in development work. A Duhring chart will permit reasonably accurate estimates of water content from knowledge of the boiling point of the resin (i.e., temperature and pressure). It is, therefore, possible from the known interrelationships of the resin properties to predict the type of resin that will be obtained for any specific set of processing conditions.

The first phenolic resins made were batch-produced in kettles, and little change has occurred in this manufacturing art in the several decades since those first resins were made. There have been good reasons for this apparent lack of progress. The reaction of phenol and formaldehyde, while superficially simple, is, in actual fact, one of the most complicated. Many products can result, and, a large number have been isolated.[1] Nevertheless, attempts to define this system by specification of the products have all been unsuccessful because of a lack of simple analytical procedures capable of distinguishing between the many products present.

Matching the complex chemical picture, the conventional kettle cycle is composed of a large number of variables (i.e., rate of heat-up, reflux time, vacuum, and total cycle time, to mention a few). A change in any one of these variables, whether deliberate or resulting from imposed factory conditions, can and usually does affect the resin quality. The resin quality itself is measured by a variety of subjective tests which depend largely, and sometimes exclusively, on the operator's skill.

Against this background, process development and factory control have been forced to proceed largely on an empirical basis. No formal procedures for analyzing process cycles and for predicting the effect of process changes have found general acceptance within the industry. Processing, at least as far as the field of phenolic resins is concerned, lies largely in the realm of an art.

In an effort to provide engineering personnel with the tools for analyzing proposed process cycles, this laboratory undertook a study directed at determining if the finished resin properties could be correlated in terms of simple variables and if these variables, in turn, could be related to the process cycle conditions through simple and well known physical-chemical principles. No attempt was made to elucidate reaction mechanisms or chemistry, as the primary objective was the development of an analytical technique that would be of value to process engineers. Further, attention was confined to resol resins as the most serious processing problems are encountered in this field.

It is our hope that the principles to be described will contribute to the more economic processing of phenolics and to the training of new personnel.

Resin properties

By analogy with other high-molecular-weight systems, it would be expected that degree of condensation, plasticizer content, and monomer conversion might be the controlling variables establishing the finished resin properties. It was further believed probable that, for any specific system, degree of condensation could be measured by "stroke cure," plasticizer content by free water or free phenolics, and monomer conversion by formaldehyde utilization. Therefore, a study of the product character-

Table I: Range of processing conditions

Process	*Time*	*Temperature*	*Pressure*	*Fraction of formalin charged to first reaction*
	min.	*° C.*	*mm. Hg*	
First reaction	30 to 50	Reflux	735 to 740	0.371 to 0.668
Second reaction	5 to 30	Reflux	735 to 740	
Dehydration	0 to 367	45 to 61	70 to 155	
Dumping		95 to 103		

*Chemical Development Dept., Chemical and Metallurgical Div. General Electric Co.

[1]Carswell, T. S., "Phenoplasts," Chapter II. 1947. New York: Interscience Publishers, Inc.

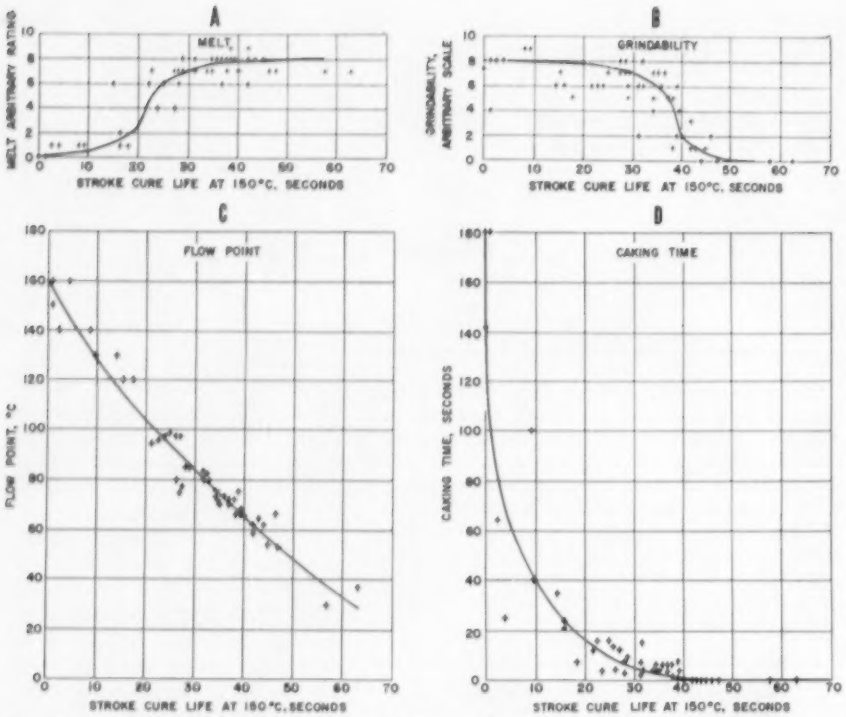

Fig. 1: Four properties of Formulation "A" *versus* stroke cure life at 150° C. (water content and free phenolic content in this formulation are low)

istics—flow point, viscosity, caking time, melt, and grindability—against the above was made.

Test procedures

Formulation "A" was prepared by reacting a deficiency of formaldehyde with phenol in an acid medium (first reaction), followed by the addition of more formaldehyde and a base to permit formation of the desired resol (second reaction).

Formulation "B" was a conventional base-catalyzed resol formulation.

All laboratory runs were made in the usual 1-l. glass or stainless steel resin kettles equipped with agitator, thermometer, and reflux or take-off condensers. Temperature changes were made as rapidly as possible in all cases. Following reaction, the resin was dumped into a cold pan and chilled rapidly.

Pilot-plant runs were made in a 25-gal. glass-lined agitated kettle equipped with condenser and all the standard accessories.

Stroke cure was determined as the time in seconds to loss of tack of a 1-g. finely powdered sample of resin stroked at a rate of 90 to 100 strokes per min. on a plate at 150° C. "Melt" was determined at the same time. The desired characteristic here was a rapid melting of the resin to a thin liquid which was assigned the value of "10" on an arbitrary scale, with incomplete fusion to a viscous, rubbery fluid representing "0." In view of the subjective nature of the "melt" test, all data were taken by the same individual.

Flow point was measured as the temperature at which a 0.100 in. thick resin coating adhering to a thermometer and heated at a rate of 2 to 3° C./min. would sag 0.200 inch.

Viscosity was determined using a Brookfield Syncro-lectric Viscosimeter Model HRF.

Free formaldehyde in either resin or distillate was determined by reacting a 2-g. sample with excess 10% hydroxylamine hydrochloride and back-titrating the liberated hydrochloric acid with 0.5N sodium hydroxide to a bromphenol blue endpoint. In the presence of resin, some difficulties were encountered initially in spotting the endpoint. With experience, accuracy improved.

Free phenolics in the distillate were determined by titration of excess bromine, the latter being supplied by the *in situ* reaction of known amounts of potassium bromate and potassium bromide in acid media. If the free phenolic content of a resin was desired, 10 g. were dissolved in 100 ml. of acetone and the resin thereupon precipitated with approximately 100 ml. of benzene and removed. The low-molecular-weight phenolics remained in solution. A substantial excess of 10% caustic was then added to render the phenolics non-volatile, and the acetone and benzene distilled off. The solution was next acidified, and low-molecular-weight phenolics and most of the water distilled overhead and weighed. The phenolic content of this distillate was then determined by titration as described above.

Free water in the resin was determined by dissolving or suspending 25 g. of finely divided resin in 100 ml. of isobutanol of known water content; 50 to 70 ml.

Table II: Correlation of resin properties with resin stroke cure for Formulation "A"

Run No.	Stroke cure at 150° C.	Flow point	Caking time	Melt	Grind	Water content	Free formaldehyde in resin	Free phenolics in resin	Distillate analysis: Free formaldehyde	Distillate analysis: Free phenolics
	sec.	° C.	min.			%	%	%		
90	63	37	0	7	0	4.29	—	—	1.01	1.72
87	58	28	0	7	0	3.48	—	—	1.73	1.79
59	47.5	53	0	7	0	2.18	0.77	1.76	1.30	2.54
63	46	67	0	7	2	4.07	0.38	3.48	1.83	1.64
95	45	54	0	8	1	1.57	0.54	2.10	0.76	1.65
67	43.9	62	0	8	0	0.74	1.32	2.60	1.39	2.56
45	42.6	64	0	9	1	0.35	0.68	2.14	1.80	2.64
71	42.0	59	0	6	3	0.23	0.41	2.53	1.92	1.57
86	42	62	0	8	1	0.81	0.38	2.07	1.93	1.85
73	40	67	0	7	2	1.06	0.53	3.88	1.82	1.15
54	39.5	69	4	8	4	0.67	0.86	1.98	1.17	2.20
56	39.0	75	7	8	6	2.56	0.82	2.24	1.13	2.14
35 & 46	38.9	67	1	9	2	0.64	0.58	1.70	1.53	2.44
60	38.2	67	2	7	1	2.00	0.85	1.29	1.34	2.87
34	38.1	72	5	8	5	1.60	0.68	1.73	1.07	1.77
91	37	72	5	6	7	0.87	0.72	2.42	0.76	1.50
94	37	70	4	8	5	0.80	0.88	2.64	1.42	1.49
49	36	73	5	8	6	1.56	0.89	3.23	1.19	1.99
84	35	70	4	8	7	0.63	1.51	2.45	1.70	1.19
41	34.7	71	4	7	4	1.28	0.71	1.56	1.64	2.56
55	34.6	75	4	7	5	1.14	0.79	1.81	1.39	2.38
50	34.6	74	5	7	5	0.76	0.88	3.59	1.39	2.20
78	34.5	73	3	7	7	0.63	0.44	3.72	1.26	1.53
75	32	80	15	7	8	1.17	0.79	1.85	1.89	1.37
62	31.9	82	4	7	6	0.15	0.89	2.18	1.23	2.43
44	31.7	80	7	8	6	0.02	0.47	1.69	1.23	2.18
38	31.4	83	2	8	2	1.10	0.41	1.31	1.26	2.15
53	29.0	85	9	7	7	1.26	0.70	2.04	1.13	2.04
42	28.9	78	9	7	6	0.81	0.58	2.27	1.13	1.58
68	28.7	85	3	6	7	1.00	0.50	5.00	0.56	1.53
39	28.6	75	8	8	5	0.37	0.40	1.30	1.13	2.30
82	28	80	12	7	8	0.15	0.50	1.27	0.88	1.32
70	27.2	97	4	7	7	0.27	0.76	2.41	1.73	1.46
85	27	97	13	4	8	2.64	0.50	1.77	0.72	1.38
43 & 61	25	98	16	6	7	0.49	0.59	1.70	0.96	1.88
72	24	97	4	4	6	1.95	0.66	1.10	0.79	1.15
36	22.4	96	16	7	6	0.44	0.46	0.93	1.44	2.04
40	22.0	95	12	6	6	0.92	1.34	1.13	2.55	1.64
92	18	120	7	1	5	0.95	1.04	1.75	0.50	1.34
64	16	120	21	2	7	1.48	0.82	2.80	0.79	1.22
93	16	120	23	1	6	0.94	0.66	1.61	0.72	1.31
32	14.6	130	34	6	6	0.97	0.14	1.46	1.13	2.19
66	9.6	130	40	1	9	0.16	0.70	1.34	1.10	2.39
83	9	140	100	1	9	0.97	0.82	1.67	0.60	1.17
69	4	160	24	1	8	0.63	0.59	2.02	0.78	2.22
37	2.3	140	65	1	8	0.92	0.48	0.95	1.29	1.28
52	1.0	150	180	0	8	1.50	0.54	1.36	1.20	1.93
77	1.0	160	—	0	4	3.98	0.50	2.42	0.57	1.25
47 & 48	0	160	142	0	8	0.77	0.26	1.28	1.23	2.14
74	0	160	180	0	7	4.23	0.31	1.52	0.72	1.60
65	0	160	180	0	7					
81	0	160	180	0	7					
76	0	160	180	0	7	3.86	0.50	1.09	0.97	0.97
80	0	160	180	0	7					

Table III: Viscosity versus water content at constant stroke cure

Batch No.	Treatment of batch	Stroke cure at 150° C.	Water content	Viscosity, corrected to 25° C.
		sec.	%	cp.
6-258 B		121	23.3	37,500
C	6-258 B vacuum dehydrated at 43° C.	119	18.2	37,500
D	" " " " "	116	12.9	43,000
E	" " " " "	118	8.90	114,000
F	" " " " "	113	6.02	870,000
G	" " " " "	114	3.22	5,700,000
Average stroke cure		117		
6-258 H	6-258 B refluxed at 60° C. to reduce stroke cure	95	18.1	142,000
I	6-258 H vacuum dehydrated at 60° C.	98	12.15	146,000
J	" " " " "	99	6.79	780,000
K	" " " " "	—	1.68	32,000,000
Average stroke cure		97		
6-258 N	6-258 B aged at room temperature to reduce stroke cure	88	20.1	132,000
O	6-258 N dehydrated at about 100° C.	83	8.99	470,000
P	" " " " "	84	5.67	2,250,000
Q	" " " " "	78	4.16	13,900,000
Average stroke cure		84		
6-260 A		110	8.10	48,000
B	6-260 A vacuum dehydrated	112	4.81	340,000
C	" " "	113	3.20	1,300,000
D	" " "	—	1.40	7,400,000
Average stroke cure		112		

of the isobutanol were next distilled slowly overhead and the water content thereof determined from specific gravity. From this, the original water content of the resin could be computed. During distillation, vacuum was applied to maintain the temperature at or below 40° C. This avoided condensation of the resin and water evolution during analysis.

Caking tendency was measured from the length of time for visual evidence of caking to develop in a finely ground resin stored at 35° C. and 100% relative humidity.

Grindability was judged on an arbitrary scale from 10 (excellent) to 0 (very poor) from the friability of individual resin lumps under the action of a mortar and pestle.

Processing conditions versus properties

Using Formulation *A*, resin properties were measured in an extensive series of 54 runs. Processing conditions were varied in accordance with an elaborate statistical design. The range of conditions covered is summarized in Table I, p. 139.

The data obtained are presented in Table II (p. 141) and Fig. 1 (p. 140). Examination of the data of Table II shows no correlation between any chemical analysis on the resin and the resin properties within the range of the data. There is also no correlation evident between distillate free phenolics and resin properties. There appears to be a small drift towards lower formaldehyde contents in the distillate as the stroke cure drops. This trend is not very pronounced, however, and one can only conclude that a chemical analysis of the resin or total distillate offers little hope as a control technique, and that monomer conversion (or formaldehyde utilization) is not a dominant variable in the range explored.

By contrast, very close correlations existed between flow point, caking time, and stroke cure. Melt and grindability gave strong indication of a definite dependence on stroke cure. (While these correlations were not as satisfactory as the others, it must be remembered that these tests were much less precise than the others.) Surprisingly, the data show these correlations depend only on stroke cure and are unaffected by the wide range of process conditions employed. This is a most important point. These correlations were felt to justify the original assumption that degree of condensation would be a controlling variable.

It was not felt that these data permitted any sound conclusion as to the effect of plasticizer content (water or phenolics) on resin properties as there was relatively little variation in these quantities; 51% of the resins had free phenolic contents between 1 and 2%, and an additional 33% fell in the range of 2 to 3%, accounting for 84% of the runs in this narrow band. Similarly, 57% of the runs had 1% or lower water content and an additional 26% had 1 to 2% (Table II).

With the importance of stroke cure (degree of condensation) thus firmly established, the possibility of a correlation between viscosity and stroke cure was next considered. Logically, such a correlation would be expected. Since resin viscosity had to be determined at the temperature and water content established by

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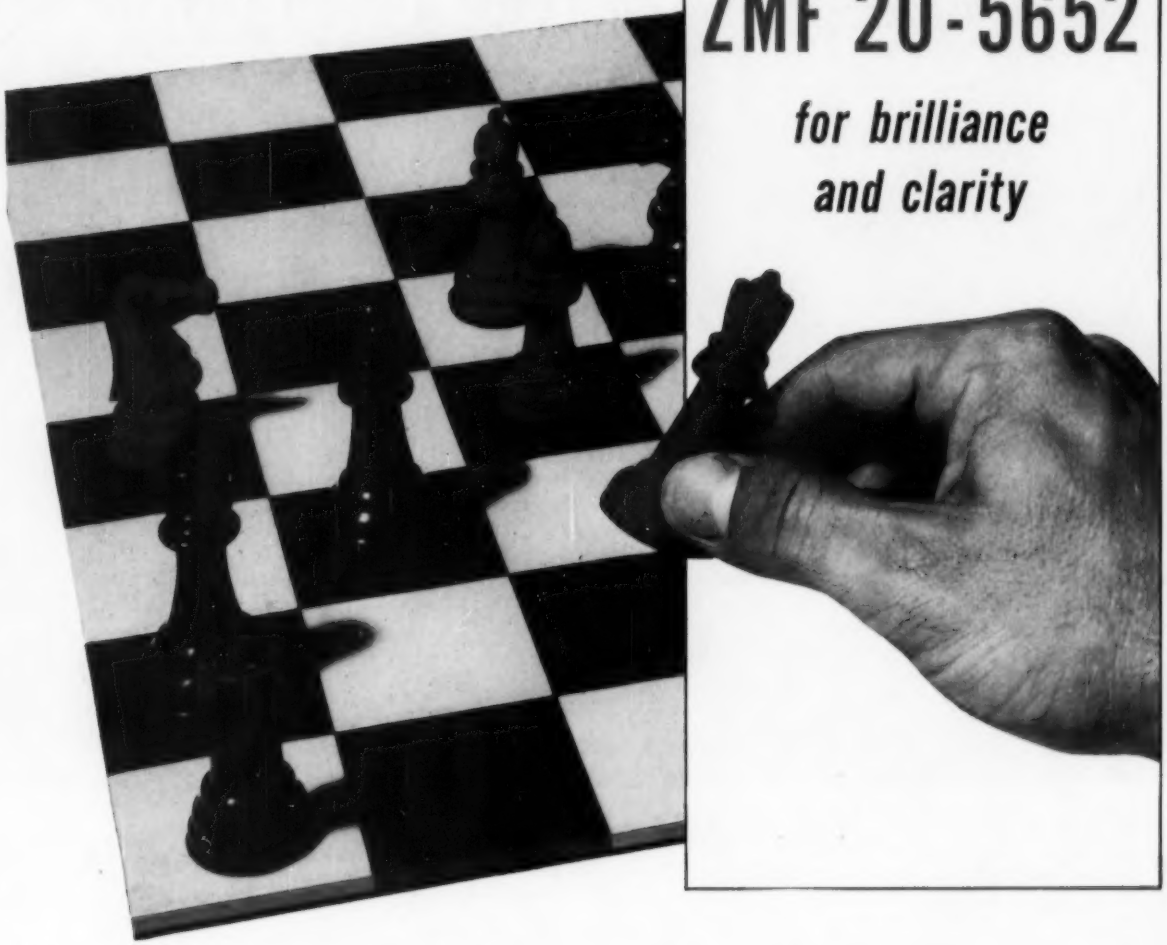

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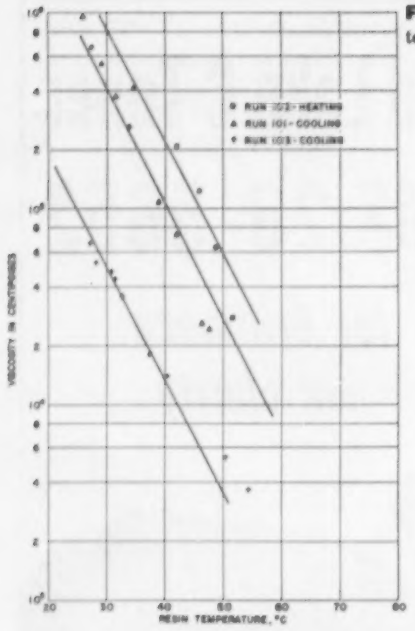


Fig. 2 (left): Viscosity of Formulation "A" *versus* temperature (cure stroke, water content constant)

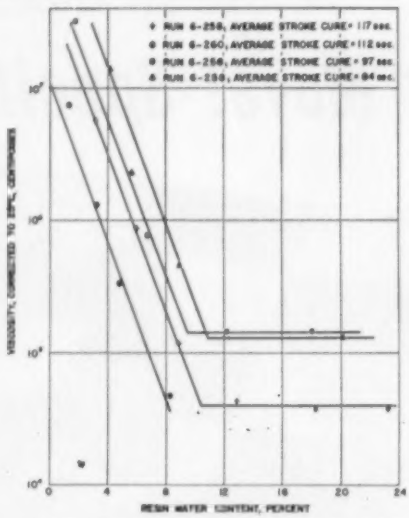


Fig. 3: Viscosity of Formulation "B" *versus* water content (cure stroke, temperature constant)

the process cycle, the redevelopment of correction curves that would permit reference of any measurement to the standard temperature, 25° C., and water content, 8%, was first undertaken. Typical data are given in Table III (p. 142) and Fig. 2, above.

Since the viscosity-temperature measurements can be represented by nearly parallel lines on semi-log paper (Fig. 2), it follows that any viscosity measurement can be corrected with respect to temperature by plotting on Fig. 2 and extrapolating from the plotted point by a line parallel to those shown. Obviously, this technique is most accurate when confined to a small temperature range. In this report, most data required correction for less than 10 to 15° C.

Figure 3, above, prepared for correction of viscosity with water

(*To page* 149)

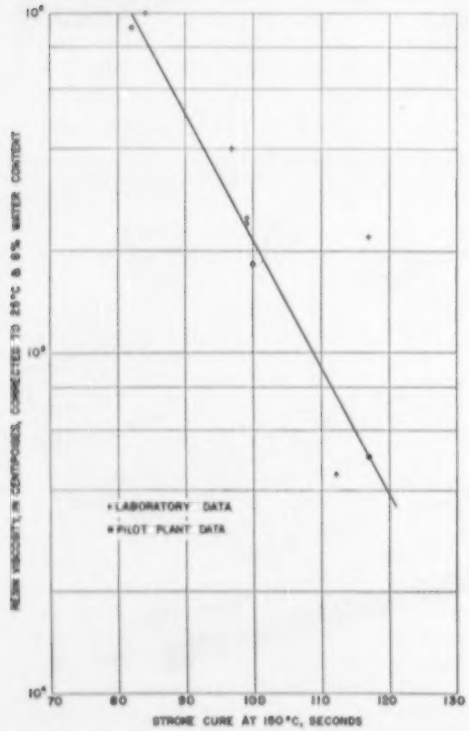

STROKE CURE AT 150°C, SECONDS
RESIN VISCOSITY, IN CENTIPOISES, CORRECTED TO 25°C & 8% WATER CONTENT
LABORATORY DATA
PILOT PLANT DATA

Fig. 4 (left): Resin viscosity of Formulation "A" *versus* stroke cure

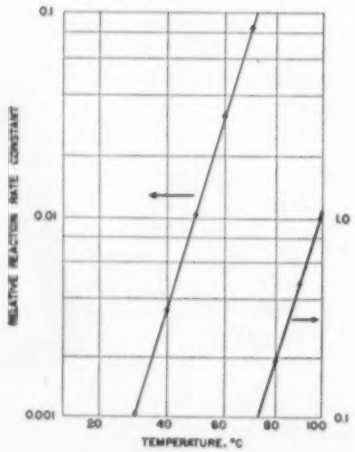
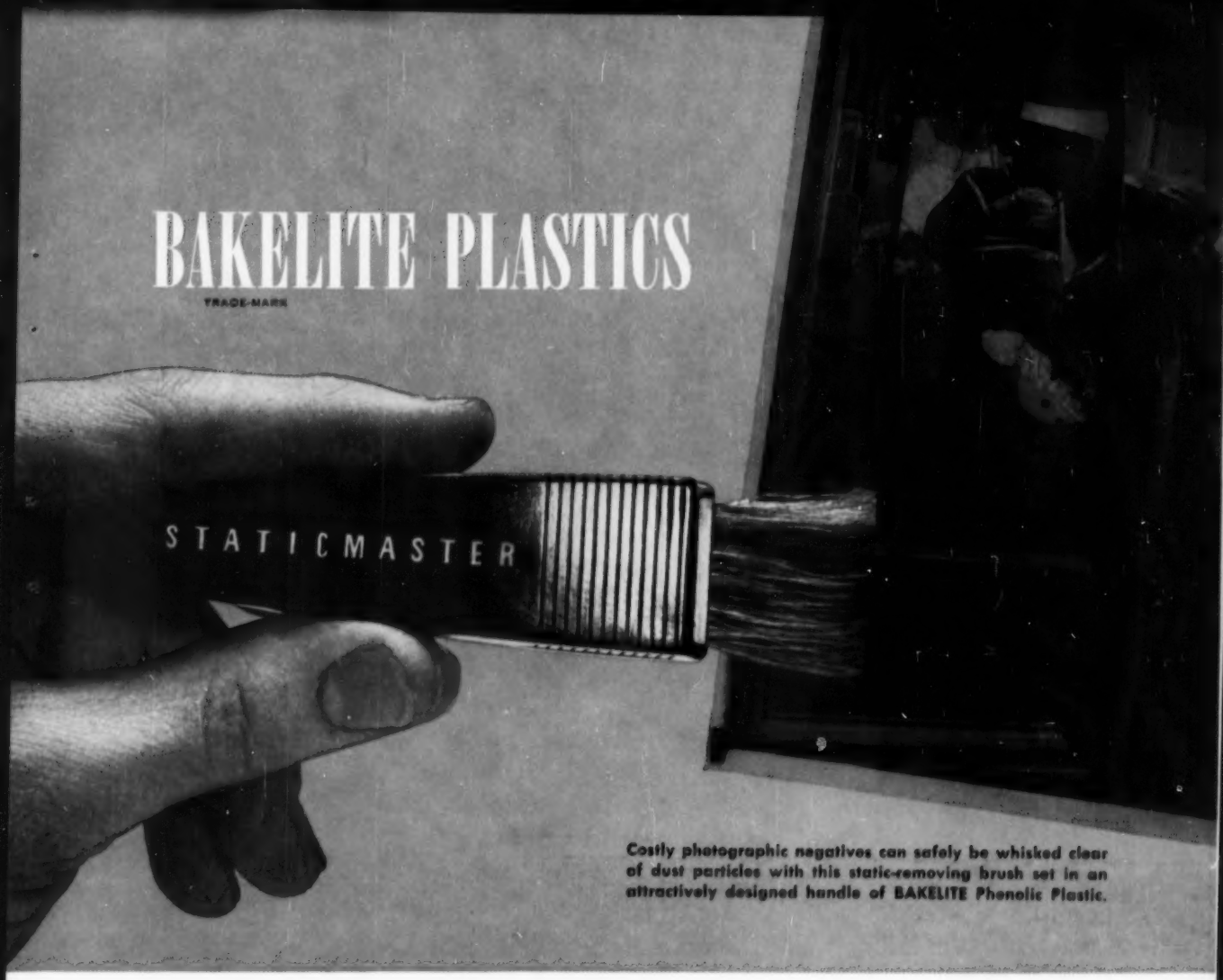


Fig. 5: Reaction rate constants for base-catalyzed resin *vs.* temperature (from Debing *et al.*, Ind. Eng. Chem. *44*, 365 (1952)



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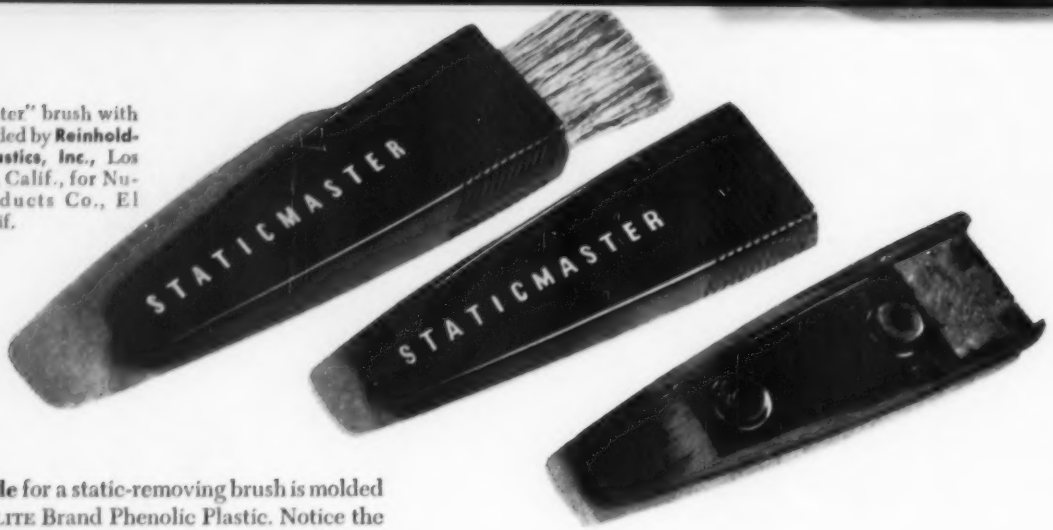
EPOXIES

(continued on next page)



"Staticmaster" brush with handle molded by **Reinhold-Geiger Plastics, Inc.**, Los Angeles 3, Calif., for Nuclear Products Co., El Monte, Calif.

This Handle for a static-removing brush is molded from BAKELITE Brand Phenolic Plastic. Notice the sharp, clear details, the clean, glossy finish, and the rich, solid black color. The ferrule of the brush contains an ionizing agent that neutralizes surfaces so that dust particles can be whisked off photographs, negatives, precision instruments, and delicate laboratory equipment. General-purpose BAKELITE Phenolic Plastic was used because it has less tendency to collect static charges. It is one of a variety of BAKELITE Phenolic molding materials. Others include special higher-strength phenolics, heat-resistant mineral-filled phenolics, and special-purpose phenolics.

Reversible Viewfinder molded of BAKELITE Brand C-11 Plastic will show either the wide-angle or telephoto shot being taken by this reversible motion picture lens. The viewfinder is injection molded to one end of a metal clip that clamps it to the lens. The tough, dimensionally stable C-11 Plastic, an acrylonitrile-styrene copolymer, holds the metal insert firmly. In production, C-11 Plastic has kept molding time to a minimum, and rejects to less than 1/10 of one per cent.

"Dual-Lens" viewfinder molded by **Douglas Engineering Co.**, Montville, N. J., for Ednalite Optical Co., Peekskill, N. Y.

"Thread Master" sewing box molded by **Crellin Plastics,** Chatham, N. Y., for Kerk Guild, Inc., McGraw, N. Y.

The Crystal Clarity of this sewing box molded of BAKELITE Brand Styrene SMD-3500 is one of its outstanding advantages. Every article it contains is completely visible, even with the close-fitting cover in place. Section partitions, spindles for spools, and the three-dimensional lettering for the manufacturer's name are all formed with clean, precise details. Surfaces are smooth and glossy. SMD-3500 also provides a combination of high plasticity and fast set-up, resulting in impressive reductions in molding cycles.

Drum liners fabricated by Denver Plastics, Inc., Golden, Colo., from sheets extruded by **Jet Specialties Co.,** Los Angeles 63, Calif.

A New Technique in Fabricating Drum Liners—cylindrical walls and flat ends formed from extruded sheets of BAKELITE Brand Polyethylene. Corrosive industrial acids don't harm this highly inert plastic. Its light weight is another advantage—only 6½ lb. for a 13-gallon liner that measures 19 inches high and 15 inches in diameter. The strong, non-shattering liner can be filled or emptied in or out of the drum. BAKELITE Polyethylene is also used for the tight-fitting pressure cap closures and a pouring spout that prevents spills, providing complete safety all around.

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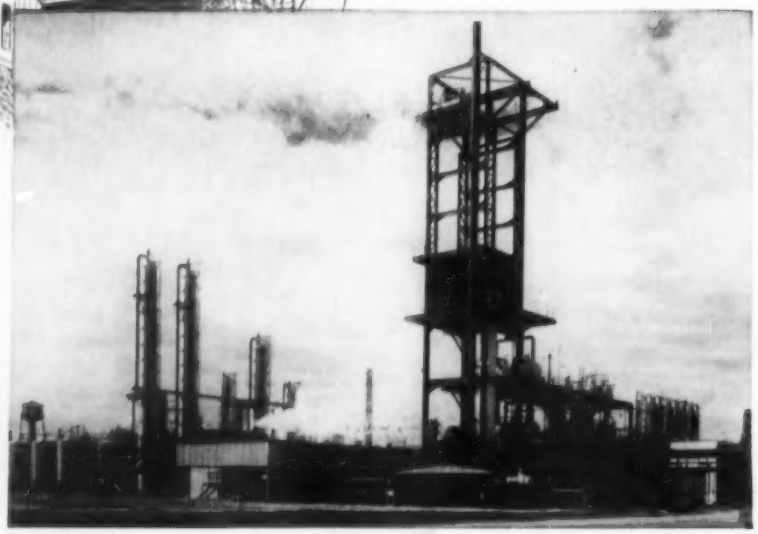

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Table IV: Variation of stroke cure with equivalent reaction time for laboratory runs with Formulation "B1"

Run No.	Time: Heat-up	Time: Reaction	Time: Dehydration	Time: Total	Dehydration Conditions: 2-phase dehydration temp.	Dehydration Conditions: Dump temp.	Equivalent reaction time at 210° F.	Resin stroke cure at 150° C.
	min.	min.	min.	min.	° F.	° F.	min.	sec.
5-128	29.5	35.5	127	192	106	110	43.8	78
5-126	33	29	96	158	104-108	113	34.6	99
5-138	36	30	138	204	108	115	33.9	104
5-136	35.5	22	72.5	130	108	113	26.2	120
5-130	40	15	99	154	107	111	20.3	143
Range	29.5-40	15-35.5	72.5-138	130-204	104-108	110-115		

content changes from Table III, is notable for two phenomena. First, the similarity of the curves is striking, especially considering that all viscosity data had to be first corrected to 25° C. using Fig. 2. Second, the curves show a sharp discontinuity at about 10 percent. This is thought to represent the possible appearance of a free water phase, emulsified in the resin. As with Fig. 2, any data to be corrected for water content are plotted on Fig. 3 and then extrapolated to the desired water content on a line parallel to those shown. It is, of course, necessary that the water content be less than 10% when the initial measurement was made.

Using the above charts, viscosity data on a consistent basis can now be examined versus stroke cure (Fig. 4, p. 144). The expected correlation is evident. It follows that viscosity may be a usable index of degree of reaction when stroke cure is not applicable (i.e., novolak manufacture). Viscosity is, however, a very much less satisfactory guide, probably because of the need for two corrections, one for temperature and one for water.

One would expect flow point and viscosity to be closely related characteristics. It has already been shown that flow point is a function of stroke cure, and it is well known from experience that this relationship is specific to the formulation. That viscosity also correlates with stroke cure is additional support for this method of organizing and presenting resin data, and leads to the conclusion that the viscosity-stroke cure relationship should be specific to the formulation.

One point (Run 5, formulation *B*) is well removed from the expected curve. This may be merely the result of experimental

Table V: Variation of stroke cure with equivalent reaction time for laboratory runs with Formulation "A"

Run. No.	Time: First reaction	Time: Second reaction	Time: Cooling to dehydration temperature	Time: Constant temperature dehydration (2-phase)	Time: Single phase dehydration	Time: Total
	min.	min.	min.	min.	min.	min
10-49	30	13	35	——30——		108
-47	30	9	17	91	8	155
-50	30	11	24	24	2	91
-48	30	7	17	62	10	126
-46	30	9.0	16	91	20	166
-53	30	7.5	11.5	39	7	115
-54	30	7	10	46	8	101
-52	30	6	9	39	11	95
Range	30	6 to 13	9 to 35	24 to 91	2 to 20	91 to 166

Run No.	Dehydration conditions: Press.	Dehydration conditions: 2-phase dehydration temp.	Dehydration conditions: Dump temperature	Equivalent reaction time at 210° F. (from start of second reaction): Second reaction	Cooling	Constant temperature dehydration	Single phase dehydration	Total	Resin stroke cure at 150° C.
	mm. Hg.	° F.	° F.	min.	min.	min.	min.	min.	sec.
10-49	45	104	125.5	10.11	6.15	——0.12——		16.38	44
-47	42	95	110	7.27	4.34	0.18	0.02	11.81	50
-50	27	81	84	9.11	1.97	——0.03——		11.11	55
-48	27	79	117.5	6.68	3.67	0.05	0.02	10.42	54
-46	44	95	102	7.88	2.03	0.18	0.05	10.11	68
-53	48	106	110	7.01	0.94	0.13	0.03	8.11	58
-54	27	81	97.5	7.50	1.00	0.04	0.01	7.55	61
-52	28	81	105	4.87	0.76	0.04	0.02	5.69	75
Range	27 to 48	79 to 106	84 to 125.5						

Table VI: Process conditions in experiments on effect of degree of reaction (stroke cure)

	Maximum change in variables	
	Formulation B1	*Formulation A*
Time for:		
Heat up	136%	—
First reaction[a]	237%	[b]
Second reaction	—	217%
Cooling to dehydration temperature	—	389%
Dehydration	191%	426%
Total time	157%	182%
Pressure during dehydration	[c]	178%
Dump temperature, °F.	110 to 115	84 to 126

[a] Formulation B1 is made in a single reaction. Formulation A requires two.
[b] First reaction time held constant at 30 minutes.
[c] Dehydration pressure held essentially constant at 55 to 60 mm. mercury.

error, compounded by corrections for both temperature and water content, or it may imply that other variables, as yet not determined, are important.

Summarizing the data to this point, they are believed to show that, for the process and systems employed, resin properties depend primarily on degree of condensation and on water content. The former is most readily measured by stroke cure, but it can apparently also be judged from viscosity corrected to standard conditions.

Process design

In the light of the foregoing data, the problem of process design is primarily one of relating the process variables to degree of condensation (or degree of reaction) and to water content.

It was anticipated that degree of reaction could be related to the process variables through classical kinetic theory. It will be recalled that the reaction rate equation for any reaction conducted at varying temperature levels can be expressed in the form

$$\int_0^\theta k\,d\theta = f(C_{o_A}, C_{o_B} \ldots C_A, C_B, \text{etc.}) \quad \text{Eq. 1}$$

assuming only that no conflicting reactions become important over the ranges of interest. In the above equation k = the reaction rate constant at the temperature, t; θ = time; C = the concentration; the subscripts A, B, etc., refer to various materials; and the subscript o refers to initial concentrations.

If θ_R is now defined as the time that would be required at some reference temperature, t_R, to obtain the same degree of reaction as was obtained in the actual process cycle (i.e., equivalent reaction time), a useful rearrangement of Eq. 1 can be made. By definition:

$$k_R\,\theta_R = f(C_{o_A}, C_{o_B}, \text{etc.}) = \int_0^\theta k\,d\theta \quad \text{Eq. 2}$$

$$\text{or} \quad \theta_R = \int_0^\theta \frac{k}{k_R}\,d\theta \quad \text{Eq. 3}$$

Now, if k/k_R is available as a function of temperature, and the time-temperature relations of the process cycle are known, then k/k_R can be plotted versus time for the specific cycle and graphically integrated to obtain θ_R.

Fortunately, relatively good data on the reaction rate of the sodium hydroxide catalyzed reaction of phenol and formaldehyde prior to resinification were recently published by Debing, Murray, and Schatz.[2] These data are plotted in Fig. 5 (p. 144) as k/k_R, where $t_R = 99°$ C., the normal boiling temperature at Pittsfield, Mass. It has been further assumed that the k/k_R ratio determined on the reaction also applied to resinification, and further that this ratio was not influenced by formulation. The results show these assumptions as reasonable.

Stroke cure versus process variables

Laboratory runs were made on two formulations, B1 (Table IV,

[2] Debing, L. M., Murray, G. E., and Schatz, J. R., Industrial Engineering Chemistry 44, 356 (1952).

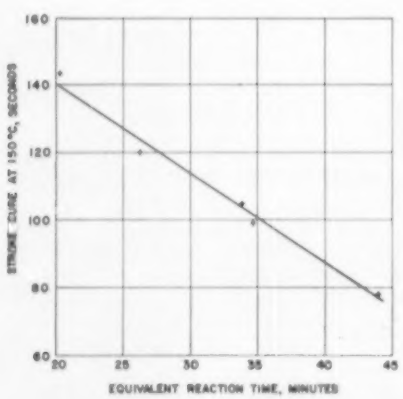

Fig. 6: Stroke cure of Formulation "B" plotted against equivalent reaction time. No stroke cure deviates from the mean by more than five seconds

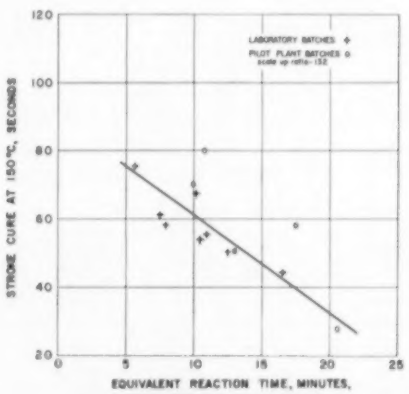

Fig. 7: Stroke cure of Formulation "A" plotted against equivalent reaction time at two levels of operation (i.e., laboratory batches and pilot plant batches)

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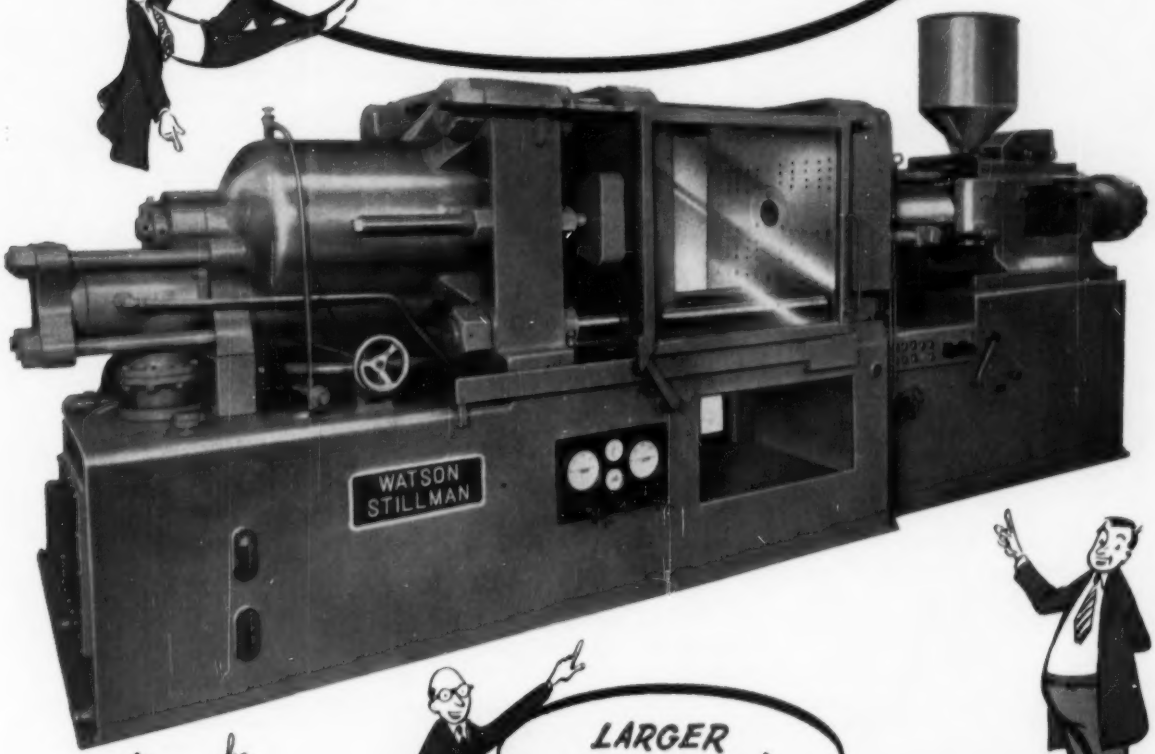

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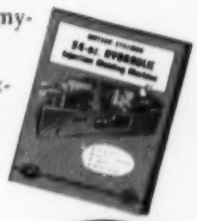

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Table VII: Variation of stroke cure with equivalent reaction time for pilot-plant runs with Formulation "A1"

Run No.	Time: First reaction	Second reaction	Cooling to dehydration temp.	Constant temp. dehydration (2-phase)	Single phase dehydration	Total cycle time	Dehydration conditions: Press.	2-phase dehydration temp.	Dump temp.	Equivalent reaction time at 210° F.	Resin stroke cure at 150° C.
	min.	min.	min.	min.	min.	min.	mm. Hg	° F	° F	min.	sec.
10-24	40	11	68	——117——		237	53	85 to 100	100[a]	20.74	28
-38	22.5	17.5	60	——225——		325	48	92 to 120	150	17.40	58
-32	25	12	25	——190——		255	41	91	145	12.92	50
-40	30	10	49	——145——		230	48	86 to 125	125	10.71	80
-27	30	10	47.5	——270——		355	28	78 to 100	120	9.73	70
Range	22.5 to 40	10 to 17.5	25 to 68	145 to 270		230 to 325	28 to 53	78 to 125	100 to 150		

[a] After chilling from 115° F.

p. 149) and *A* (Table V, p. 149). Process conditions were varied widely as shown in Table VI (p. 150) and in detail in Tables IV and V.

The data are plotted in Figs. 6 and 7, p. 150. In Fig. 6, no stroke cure deviates from the mean line by more than 5 seconds. In Fig. 7, the stroke cures of all laboratory runs are within ± 10 sec. of the mean line, and 75% of the data (i.e., six runs) fall within ± 5 sec. of this trend line. It is to be noted that the relations developed are specific to the formulation.

The relatively close correlation of these data, despite the wide range of process variables employed and despite the several assumptions made in using the reaction rates of Debing et al, is believed proof of the soundness of this approach. Also, theoretically, the curves of Figs. 6 and 7 should be parallel. Inspection shows they are lending additional support to the validity of this approach.

Obviously, improvement in the correlations obtained can be expected if data on both reaction and resinification rates for the specific system under consideration can be employed. Still further improvement might result from refinement of the stroke cure test, or from substitution of a less subjective test for degree of condensation. Nevertheless, at the present state of development, this approach is fruitful.

The possibility of using this technique to predict product properties from the process cycle when scaling-up from laboratory to pilot plant was next studied. A formulation (*A1*) closely similar but not identical to formulation *A* was processed in a 25-gal. pilot-plant reactor. It was believed that the formulation differences were sufficiently small that their influence would be minor.

The scale-up quantity was 132-fold. The increase in average total cycle time was 2.3-fold. Both scale-ups are relatively large considering the thermally sensitive nature of the resins. In normal practice, with resins of this type, the increase in batch size would have been made in smaller jumps, and the process cycles at each increase in batch size would have been held in close agreement. On top of this, the pilot-plant runs showed a 141% range in total cycle time

(*To page* 248)

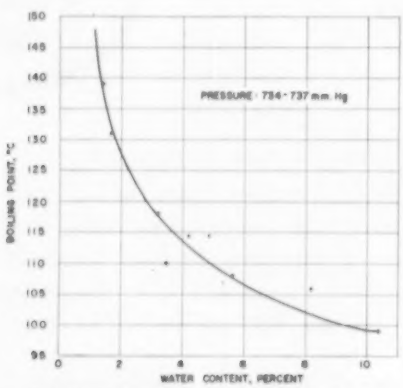


Fig. 8: Boiling point of a modified Formulation "B" as it was determined by successive experiments, using fresh resin for each

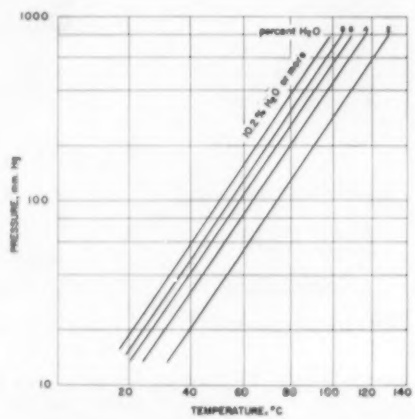
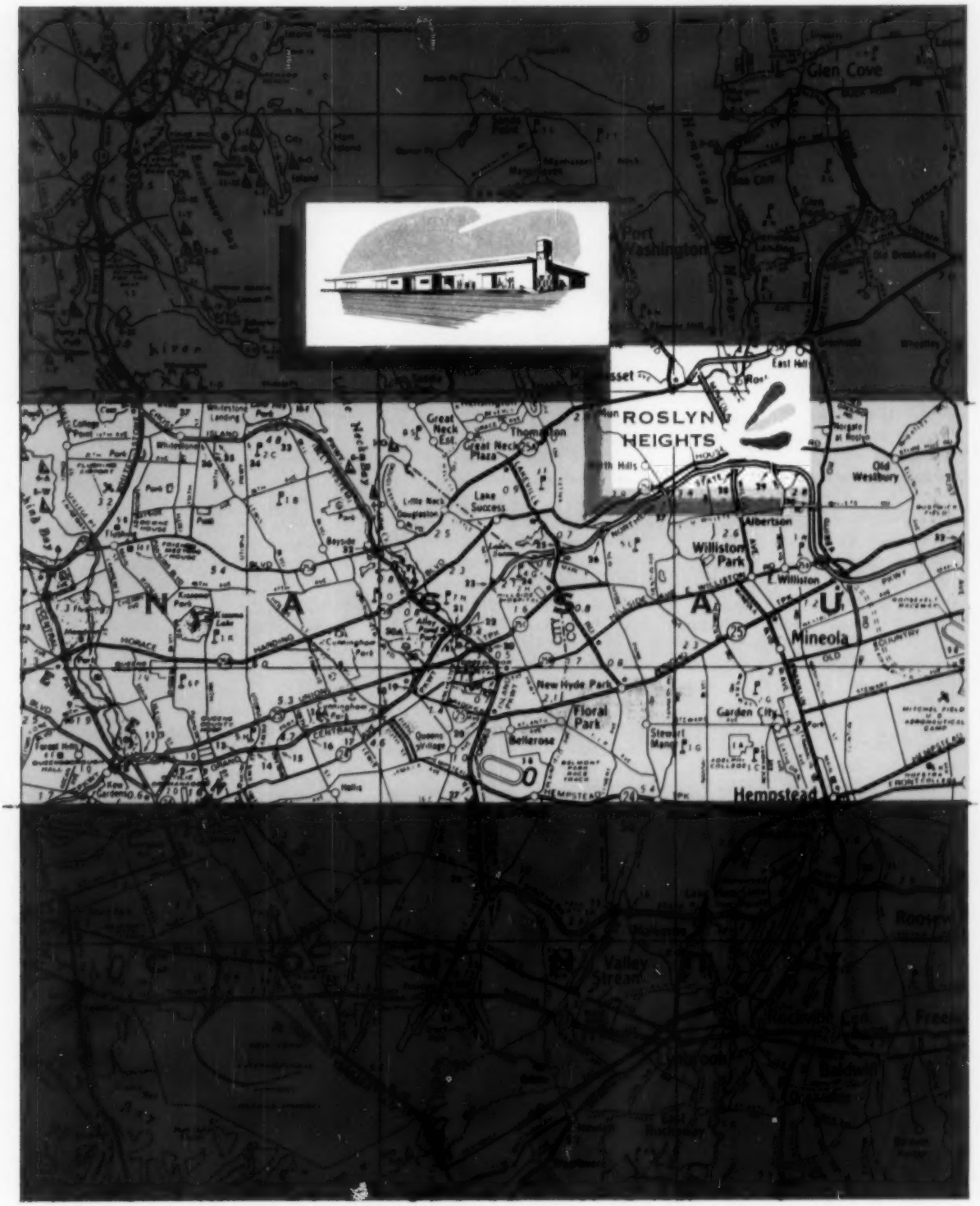


Fig. 9: Boiling point-pressure curves for resin *vs.* water content for a modified Formulation "B" resin



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Plastics Digest

Abstracts from the world's literature of interest to those who make or use plastics or plastics products. For complete articles, send requests direct to publishers. List of addresses is at the end of Plastics Digest.

Materials

Fibers enter the metal field. Chem. Eng. News *33*, 4404 (Oct. 17, 1955). Flexible metal fibers are described. One type of construction that offers promise is metal fiber-reinforced plastics. The metal fiber would increase the elastic modulus, the heat resistance, and strength.

β-Vinyloxyethyl methacrylate. H. C. Haas and M. S. Simon. J. Polymer Sci. *17*, 421-25 (July 1955). β-Vinyloxyethyl methacrylate was polymerized. Some properties of the polymer are reported.

Linear polyesters derived from vanillic acid. L. H. Bock and J. K. Anderson. J. Polymer Sci. *17*, 553-58 (Aug. 1955). Vanillic acid, which is potentially available from lignin, was converted to dibasic acids by etherifying the phenolic hydroxyl group with alkylene dihalides. The dibasic acids were esterified with ethylene glycol and condensed to linear polyesters. The polyesters were converted to fibers by melt spinning. The fibers could be stretched, preferably in a warm water bath, to give fibers with good tenacity and increased crystallinity as shown by birefringence measurements. The polyester obtained from ethylene-divanillic acid melted at 210° C., but softened and shrank at 80° C.

Epoxy-furan blends. W. Brenner and E. J. Singer. Materials & Methods *41*, 102-04 (June 1955). The cost of epoxy laminates can be reduced considerably by blending up to 40% by weight with a furfural-ketone resin. The blended product compares favorably with straight epoxies in physical and chemical properties. Data are presented to show the effect of furan content on laminate strength for various types of reinforcement, and the effect of exposure to heat and to various chemicals.

Metallized plastic films. T. Hammer. Product Eng. *26*, 182-85 (Aug. 1955). Deposition of metal on plastic sheet by the vacuum evaporation method provides new materials with excellent light reflectivity, and useful combinations of electrical and heat conductivity. Either cathode sputtering or thermal evaporation processes can be used. The properties and uses of plain or laminated films with coatings from 2½ to 16 millionths in. thick are discussed. Suitable plastic base materials include Mylar polyester film, cellophane, cellulose acetate, polystyrene, polyethylene, and vinyl chloride-acetate. A variety of metallic color effects and embossing patterns are possible. Heat-sealing generally is not affected by metallization, except in the case of electronic sealing where the electrical conductivity of the thin metal layer causes difficulty. With proper selection of base material, metallized films can be vacuum formed and can be successfully laminated to many other materials.

Radiation protection in copolymers of isobutylene and styrene. P. Alexander and A. Charlesby. Proc. Royal Soc. London *230A*, 136-45 (June 7, 1955). The effect of ionizing radiations on copolymers of isobutylene and styrene was studied. Molecules consisting only of isobutylene units degrade under radiation to the neighboring isobutylene units. An estimate is given for the extent of this protection. On irradiation the copolymer at first degrades to an extent which depends on the percentage of styrene, then it cross-links partially into a gel. Even for copolymers containing 80% of styrene, protection is only partial, and after high radiation doses specimens separate into a gel and a sol fraction. It is not possible to cross-link such copolymers sufficiently to produce a completely insoluble material. Chemical analysis of the irradiated copolymer shows that the separate units are distributed approximately at random throughout the material, and do not occur in large blocks rich in styrene or isobutylene.

Molding and fabricating

Finishes for plastics. J. B. Vampbell. Materials & Methods *41*, 119-34 (June 1955). Finishes for plastics are comprehensively reviewed. Included are paint and ink finishes, metallic finishes, flock finishes, and others. The types of finishes available are described. The methods of applying them, their advantages, and their limitations are discussed, taking into account the nature of the plastic material to be coated. Special problems peculiar to the painting of plastics are pointed out, including etching, crazing, plasticizer migration, and solvent absorption. The types of finishes to be considered in achieving specific functional purposes or decorative effects are indicated.

Statistical quality control X. Statistical experiment in plastics fabrication. E. C. Harrington. SPE J. *11*, 19-21 (June 1955). An example of the factorial experiment in studying the variables in a molding process is given. This experiment permits the evaluation of many variables simultaneously. Analysis and interpretation of the results are discussed.

Adhesive bonding. J. L. Been. Product Eng. *26*, 181-86 (May 1955). An adhesive must be in liquid form to make a bond. The strength of the final bond depends on what happens when the adhesive dries, cools, or cures. Adhesives are available in two basic forms: 1) dispersed in a fluidizing

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carrier solvent, either organic or aqueous, and 2) free of volatile carrier. The first type is more common because of ease in application and drying, but the volatile-free adhesives are more practical for assembly-line structural bonding where maximum bond strengths are required. A checklist is given of points to be considered in the proper selection of adhesive materials and process of application for operations such as bonding, flocking, sealing, coating, and impregnating.

Welding and powder spraying of plastics. J. A. Neumann. Plastics Tech. *1*, 475-77, 498 (Sept. 1955). The advantages, operation, and applications of welding and powder spraying of plastics are discussed.

Applications

Dimensional stabilization of textile fabrics. N. A. Matlin and A. C. Nuessle. Ind. Eng. Chem. *47*, 1729-39 (Sept. 1955). Dimensional stability—the dual resistance of fabrics to the tendency to shrink and stretch—is of extreme importance in fabrics used for the manufacture of clothing. Chemical processes extend the range of fiber and fabric types that can be stabilized. The mechanics of shrinkage vary with the type of shrinkage and of fiber. Cotton and rayon shrink because of fiber swelling, wool because of felting, and the hydrophobic synthetics because of thermal disorganization and mechanical distortion. All shrink when strains developed in manufacturing are released. Treatment of rayon and cotton with cellulose reactants and thermosetting resins, especially urea- and melamine-formaldehyde resins, has been effective, and various classes of felt roofing systems are used with wool. The chemical reaction between keratin and an acrylic resin is needed for the production of a durable finish.

Nylon-coated metal parts for wear resistance. L. L. Stott. Materials & Methods *41*, 92-94 (June 1955). Development of a relatively inexpensive method for applying thin, strongly-adherent coatings of nylon to metal surfaces makes it possible to combine the desirable frictional and wear properties of nylon with the greater strength, greater dimensional stability, and lower cost of metals. The metal part is preheated to a certain temperature above the melting point of the nylon, then dipped into nylon which is in a specially-prepared solid form. The result is a homogeneous, solvent-free coating that needs no after-bake or other hardening treatment. Correct preparation of the metal surface is an important factor. Potential uses include lock nuts, gears, sleeve bearings, bushings, cams, hinge pins, and automobile or refrigerator doors.

Missing links in cellar-to-roof plastics. Chem. Week *77*, 54, 56, 58, 60 (Oct. 8, 1955). Some problems concerned with the greater extension of plastics in the building field are discussed.

Coatings

Ultra modern lab coater becomes important tool in marathon research. W. I. Stinger. Paper Trade J. *139*, 90, 92, 94 (May 9, 1955). To meet the ever increasing demand for better process printing for packaging, a research laboratory coater was developed that avoids the inadequacies of ordinary laboratory coating methods and the expense, loss of production time, and inflexibility of machine trials on production equipment. The research laboratory coater is flexible in design to permit development of new and reproduction of as many of the standard coating and sizing methods as possible. It is large enough in scale to assure reproduction of results when translated to mill scale but not so large as to be unwieldy to operate. Its construction is of an "erector set" type that permits dismantling, rebuilding, or modification with minimum labor and expense. Lightweight paper to heavy paper board can be coated on one or both sides at speeds ranging from 100 to 1000 ft. per min. with a maximum web width of 10 inches. A detailed description of the construction and principle of operation of the research coater is given along with schematics and photographs.

Abrasive jet method for measuring abrasion resistance of organic coatings. A. G. Roberts, W. A. Crouse, and R. S. Pizer. ASTM Bulletin No. 208, 36-41 (Sept. 1955). A new rapid method for measuring the abrasion resistance of organic coatings on metals is described which utilizes a jet of fine abrasive particles under closely controlled conditions of pressure, distance, angle, and flow to abrade through the coating. The small scale of operation permits the economical use of a continuously fresh supply of abrasive material. Abrasion resistance is expressed in terms of the time required to abrade through a unit thickness of coating. Values are obtained with an average coefficient of variation of about 5 percent. The abrasion time depends strongly on the test conditions. It increases almost linearly with increasing nozzle-to-coating distance, decreases with increasing pressure, and decreases markedly with decreasing angle of abrasion of 90° down to about 30°; at lesser abrading angles, the abrasion rises again. It is possible that different abrading angles may give different correlations with actual service. It is postulated that a 90° test may simulate leading-edge erosion, while a 45° test may more nearly simulate the scuffing type of wear encountered during maintenance operations.

Properties

Thermal degradation of polychlorotrifluoroethylene, poly-α-β, β-trifluorostyrene, and poly-p-xylylene in a vacuum. S. L. Madorsky and S. Straus. J. Research Nat. Bur. Standards *55*, 223-30 (Oct. 1955). Polychlorotrifluoroethylene (Kel-F) (I), poly-α, β, β-trifluorostyrene (II), and poly-p-xylylene (III) were pyrolyzed under conditions of molecular distillation, and some of the light volatile fractions analyzed in the mass spectrometer. The volatiles from (I) consisted of 27.9% by weight monomeric fragments, mostly monomer, and 72.1% large fragments of average molecular weight 904. In the case of (II), the volatiles consisted of 73.6% monomeric fragments, almost all monomer, and

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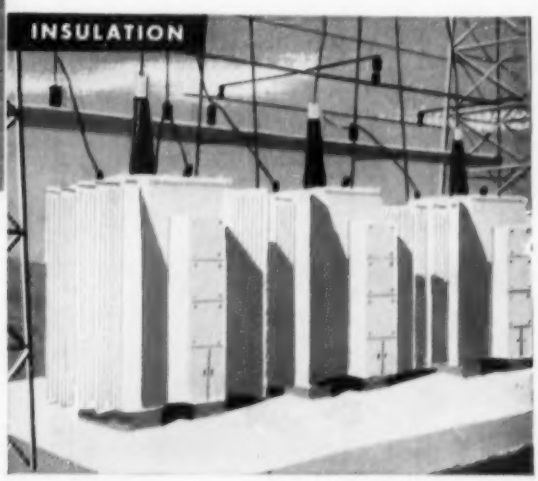

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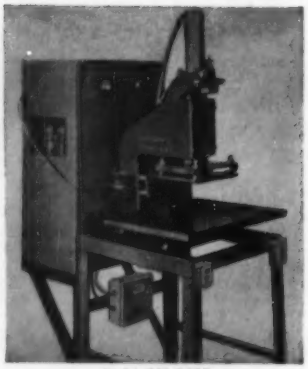

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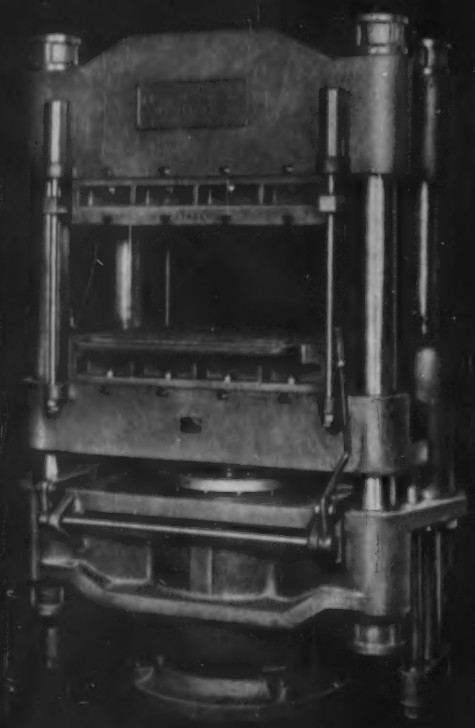

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26.4% large fragments of average molecular weight 458. The volatiles from (III) consisted of 3.6% monomeric fragments, not containing any monomer, and 96.4% large fragments of average molecular weight 661. Rates of thermal degradation, in terms of rates of volatilization, were also investigated. The activation energies calculated from these rates are 66, 67, and 76 kilocalories per mole for (I), (II), and (III), respectively. The following order of thermal stability was found: (III)>(I)>(II).

Microscopic examination of glass fiber reinforced plastics. M. K. Weber. ASTM Bulletin No. 208, 49-51 (Sept. 1955). A technique for studying the fine structure of glass fiber reinforced plastics with microscopic apparatus is described. Defects not readily apparent by other tests are revealed by this technique.

Determination of crystallinity in polyethylene by X-ray diffractometer. S. L. Aggarwal and G. P. Tilley. J. Polymer Sci. *18*, 17-26 (Sept. 1955). A convenient and rapid X-ray diffraction method is described for the determination of percent crystallinity in polyethylene, using a scanning goniometer with Geiger tube and scaler counter. Results are presented on percent crystallinities of a number of polyethylenes and on samples made by quenching polyethylene melt at different temperatures in the range of 20 to 102° C. The temperature at which polyethylene melt is quenched has no appreciable effect on the crystalline content.

The dispersion meter design and development. G. Mole. Elec. Research Assoc. Technical Report V/T121 (1954): DISPERSION METER, MODEL. INSTRUCTION MANUAL. Technical Report V/T124 (1955). Measurement of dielectric dispersion (i.e., the relative increase in instantaneous capacitance) over the time range 3 to 300 μsec. has been found to be a useful method of testing insulation, since it is sensitive to significant quantities of moisture and yields zero response for dry specimens. An instrument to measure this dispersion is described and instructions for calibrating and using it are given.

Testing

Measurement of the degree of cure of polyester resins by the Wallace Micro Indentation Tester. F. N. B. Bennett and R. Hayes. Plastics (London) *20*, 282-84 (Aug. 1955). It is shown that the Wallace Micro Indentation Tester can estimate the degree of cure by measuring the surface hardness of unfilled polyester resins and resins containing glass reinforcement. The instrument is described; it measures the depth of penetration of an indentor, under a known dead load, into the test material. This is done by measuring the exact position of the indentor before and after the load is applied, using a simple electronic "null" indicator. Tests were conducted on an unfilled polyester resin and on the resin reinforced with glass mat and with glass cloth. The depth of indentation was measured as a function of time of application of load for different curing times and temperatures. The results show that the hardness increases and the rate of increase of depth of penetration decreases as the cure improves with increase of time or temperature of curing.

Publishers' Addresses

A.S.T.M. Bulletins: American Society for Testing Materials, 1916 Race St., Philadelphia, Pa.
Chemical and Engineering News: American Chemical Society, 1115 Sixteenth St., N. W. Washington, D. C.
Chemical Week: McGraw-Hill Publishing Co., Inc., 330 W. 42dn St., New York 18, N. Y.
Electrical Research Associates: The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Rd., Leatherhead, Surrey, England.
Industrial and Engineering Chemistry: American Chemical Society, 1115 Sixteenth St., N. W. Washington 6, D. C.
Journal of Polymer Science: Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y.
Journal of Research of the National Bureau of Standards: Superintendent of Documents, Government Printing Office, Washington 25, D. C.
Materials and Methods: Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.
Paper Trade Journal: Lockwood Trade Journal Co., Inc., 15 W. 47th St., New York 36, N. Y.
Plastics (London): Temple Press Ltd., Bowling Greene Lane, London E. C. 1, England.
Plastics Technology: Bill Brothers Publishing Corp., 386 Fourth Ave., New York 16, N. Y.
Proceedings Royal Society London: The Royal Society, Burlington House, Piccadilly, London W. 1, England.
Product Engineering: McGraw-Hill Publishing Co., 330 W. 42nd St., New York 18, N. Y.
SPE Journal: Society of Plastics Engineers, Inc., 513 Security Bank Bldg., Athens, Ohio.

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U.S. Plastics Patents

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Film. W. M. Wooding and T. J. Suen (to American Cyanamid). U. S. 2,719,798, Oct. 4. Cellulose film containing urea resin.

Coatings. K. Craemer and F. Hoelscher (to Badische Anilin). U. S. 2,719,832, Oct. 4. Moistureproof coatings for fabrics.

Polytetrafluoroethylene. R. S. Vincent and F. J. P. J. Burger (to British Dielectric Research). U. S. 2,719,833, Oct. 4. Milling polytetrafluoroethylene mixed with polyisobutylene.

Polymers. A. B. Craig and G. E. Ham (to Chemstrand). U. S. 2,719,834, Oct. 4. Fiber-forming copolymers of acrylonitrile.

Polyesters. R. L. Sublett (to Chemstrand). U. S. 2,719,835, Oct. 4. Nitrogen-containing linear polyesters.

Polymers. H. D. Anspon (to General Aniline). U. S. 2,719,836, Oct. 4. Polymeric 2,3-dichloroprene.

Polyester resins. E. H. Phreaner (to H. Calvin White). U. S. 2,720,004, Oct. 11. Curing polyester resin in a rubber mold.

Housing. J. E. Holt (to Danielson Manufacturing). U. S. 2,720,332, Oct. 11. Hollow plastic housing.

Cellulose ethers. A. W. Anderson and B. V. Moeller (to Dow). U. S. 2,720,464, Oct. 11. Cold-water-soluble cellulose ethers.

Glass fiber treatment. P. W. Erickson and I. Silver (to U. S.). U. S. 2,720,470, Oct. 11. Allylaroxydichlorosilane treatment of fibers.

Polymers. R. A. Crawford and R. T. Morrissey (to B. F. Goodrich). U. S. 2,720,479, Oct. 11. Brominated monoolefin polyolefin interpolymer.

Resin. C. E. Bushnell (to Armstrong Cork). U. S. 2,720,496, Oct. 11. Aqueous dispersion of polyvinyl acetate.

Plastic. A. F. Benning and F. B. Hill, Jr. (to Du Pont). U. S. 2,720,498, Oct. 11. Polytetrafluoroethylene plasticized with chlorofluoro telomers.

Polyesters. W. P. Cody (to Alkydol Laboratories). U. S. 2,720,500, Oct. 11. Polyesters.

Resins. P. T. Van Ness (to Du Pont). U. S. 2,720,501, Oct. 11. Condensates of polyvinyl acetal resins.

Catalysts. J. R. Caldwell (to Eastman Kodak). U. S. 2,720,502-3-4-5-6-7, Oct. 11. Catalysts for polyesters.

Resins. S. Melamed (to Rohm and Haas). U. S. 2,720,508, Oct. 11. Polyureidopolyamides.

Resins. A. C. Dees (to Phillips Petroleum). U. S. 2,720,509, Oct. 11. Sulfur-containing resins from 4-vinyl-1-cyclohexene.

Copolymers. M. E. Cupery and J. C. Saner (to Du Pont). U. S. 2,720,511, Oct. 11. Copolymers of beta-vinyl-oxyethylamine and alpha-methylene monocarboxylic acid.

Polymers. J. M. Butler (to Monsanto). U. S. 2,720,512, Oct. 11. Polymers of cyano ether-esters of acrylic acid.

Rosin. A. L. Rummelsburg (to Hercules). U. S. 2,720,513-4, Oct. 11. Rosin condensates.

Tubing. M. G. Gerow. U. S. 2,720,680, Oct. 18. Method of producing flattened plastic tubing.

Molding. E. L. Danielson and F. J. Dofsen. U. S. 2,720,681, Oct. 18. Molding peripheral indicia.

Leather treatment. N. D. Cheronis. U. S. 2,721,145, Oct. 18. Impregnating leather with polymers.

Cellulosic compositions. W. G. Grantham (to American Viscose). U. S. 2,721,150-1, Oct. 18. Cellulosic particles coated with vinyl chloride copolymers.

Resinous products. T. L. Cantrell, J. G. Peters, and H. G. Smith (to Gulf Oil). U. S. 2,721,176, Oct. 18. Oil-soluble metal and sulfur containing resinous condensate.

Polymers. P. O. Tawney (to U. S. Rubber). U. S. 2,721,186, Oct. 18. Polymers of N-carbamylamic acid esters.

Polymers. A. W. Anderson and N. G. Merckling (to Du Pont). U. S. 2,721,189, Oct. 18. Polymeric bicyclo-(2,2,1)-2-heptene.

Ship. H. B. Roberts and E. S. Wood (to Roberts Industries). U. S. 2,721,341, Oct. 25. Dual-welt plastic ship.

Polystyrene. F. Hochberg (to U. S.). U. S. 2,721,357, Oct. 25. Electrically conductive polystyrene articles.

Tube closure. A. Nichols (to Celluplastic). U. S. 2,721,595, Oct. 25. Plug cap for plastic extruded tube container.

Glass rods. R. V. Van De Vanter (to Orchard Industries). U. S. 2,721,599, Oct. 25. Resin-bonded glass fiber fishing rods.

Cellulose fibers. G. C. Daul, J. D. Reid, and R. M. Reinhardt (to U. S.). U. S. 2,721,784, Oct. 25. Reacting cellulose fibers with beta-propiolactone.

Glass rods. A. E. G. von Reis, S. E. Kreisher, P. Quitter, and T. S. Williamson (to Orchard Industries). U. S. 2,721,820, Oct. 25. Making resin bonded glass fiber rods.

Printing. K. S. Hoover (to A. B. Dick). U. S. 2,721,821, Oct. 25. Printing on plastic containers.

Resin. E. L. Gustus. U. S. 2,721,827, Oct. 25. Polyamine resin having an anion of p-aminosalicylic acid adsorbed thereon.

Polymers. M. R. Lytton (to American Viscose). U. S. 2,721,849, Oct. 25. Linear condensation polymers of a polymethylene glycol and a diaminodiphenyl.

Plasticizer. P. R. Hawtin and J. A. John (to British Celanese). U. S. 2,721,850, Oct. 25. Cellulose esters plasticized with a condensation polymer.

Resins. R. J. Fanning (to Phillips Petroleum). U. S. 2,721,851, Oct. 25. Thermally stable sulfone resins.

Pulley. L. E. Caldwell (to Westinghouse). U. S. 2,722,130, Nov. 1. Molded laminated pulley.

Pipe. R. W. Rosel (to Yardley Plastics). U. S. 2,722,237, Nov. 1. Plastic pipe with attached tensile load-bearing member.

Coating. G. B. Field, W. H. Markwood, and G. M. Taylor (to Hercules). U. S. 2,722,340, Nov. 1. Coating of poly-3,3-bis(chloromethyl)oxetane.

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Rated injection capacity is 2 to 3 oz., with plasticizing capacity of 60 lb./hour. A volumetric displacement, spillway-type feed mechanism is claimed to provide high accuracy in the flow of powder to the heating cylinder. The cylinder, of simplified construction, is removable. Three-zone heat control is provided by proportioning-type pyrometers.

Injection plunger and bracket are water-cooled. The injection assembly is retractable from the die platen.

The hydraulic clamp mechanism exerts a pressure adjustable to 125 tons with a maximum stroke of 15 inches. The clamp is provided with a positive adjustable cushion on both opening and closing strokes. The hydraulic system (reservoir, vane-type pumps, oil cooler, filter, control valves, etc.) is mounted on the machine. Platens are furnished with T-slots, T-bolts, and 10 adjustable knockout points.

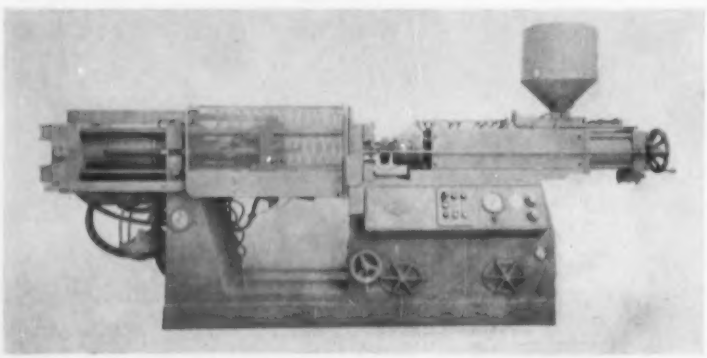
Except for the manual cycle, the injection and clamp mechanism are electrically interlocked to prevent injection until the clamp is fully closed.

Guards and a sliding gate which allows the machine to operate only when closed provide operator protection. When a cycle is delayed for any reason in automatic operation, an over-all timer times out and shuts the motor and heating bands off and turns on a red light. In addition, provisions for audible alarm are also incorporated.

Summary of specifications follows:

Clamping daylight, open, spacers (in.)	30, 27, 24
Clamping daylight, closed, spacers (in.)	15, 12, 9
Die platen dimensions (in.)	
Over-all, front to back	17
Over-all, up and down	14½
Between tie rods, front to back	10½
Between tie rods, up and down	7½
Capacity of feed hopper (lb.)	100
Injection pressure, plunger (p.s.i.)	20,000
Injection plunger diameter (in.)	2
Injection stroke (in.)	6
Injection plunger speed (in./min.)	165
Clamp pressure, adjustable (p.s.i.) max.	5500
Oil reservoir capacity (gal.)	60
Motor (hp.)	20

The machine, in addition to fully automatic operation, also provides single cycle automatic and manual operation. The motor operates on 220/440-v., 60-cycles, three-phase lines. Dimensions of the machine are 154 in. long, 64 in. wide, and 72 in. high. Weight is 8000 pounds. *Improved Machinery, Inc., Nashua, N. H.*



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Safety tags, seals, cloak room checks, and other tags and tickets can be produced at rates of several hundred per minute on a die-set assembly that incorporates a series of punches, stamps, blanking dies, and other equipment. The die-set is of a standard sleeve type and fits into any standard 10-ton (or larger) punch press. The assembly consists of a set of hole punches, followed by a set of stamping dies which stamps name, trademark, or other lettering. This is followed by blanking dies. Where numbering is required, that operation precedes the hole punching, and is accomplished with an automatic numbering head which is actuated at each stroke of the press.

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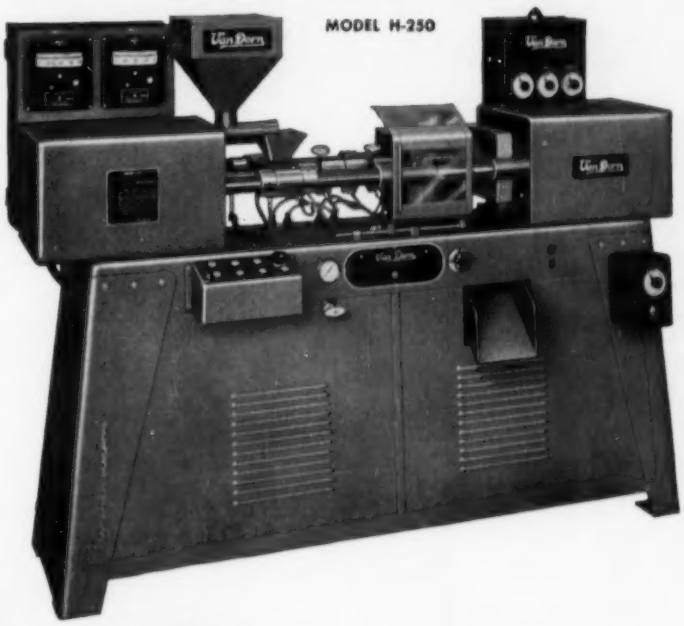

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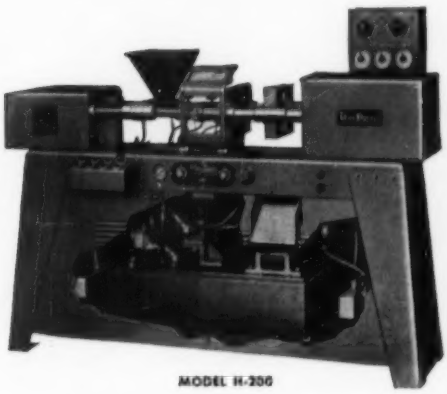

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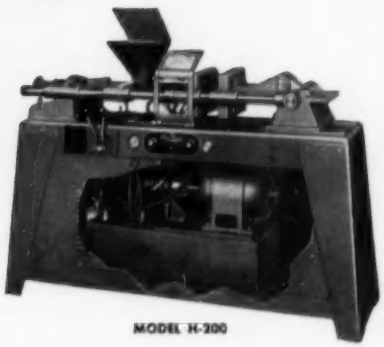

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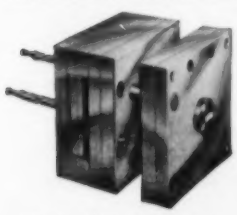

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Black oxide finish: now a standard finish on cylinder heads, caps, mountings, pistons, followers, tie rods, and the unplated portions of piston rods of all air and hydraulic cylinders; this black ferric oxide finish provides rust protection on all cylinders during shipping and installation. *Miller Fluid Power Co., 2040 N. Hawthorne Ave., Melrose Park, Ill.*

Marker-cutter

Model KTL-1 marks code identification in color on flexible insulating tubing (spaghetti) using flat face marking type, and cuts the marked sleeves to desired length. A universal holding fixture accommodates tubing from 3/32- to 5/8-in. O.D. round. Production rate is approximately 60 pieces per minute.

Kingsley's Model KTL-1 color-codes and cuts flexible insulating tubing to size

The machine is equipped with an adjustable depth gage to regulate depth of marking, an automatic foil feed, and a heat regulator. It operates from 115-v. a.-c. or d.-c. lines. Base of the machine is 7½ by 12 in., over-all height is 12 in., weight is 30 pounds. *Kingsley Stamping Machine Co., 850 Cahuenga Blvd., Hollywood 38, Calif.*

Thread inserts

Recommended by the manufacturer for use in all plastics materials, the Pip push insert makes it unnecessary to tap internal threads in a hole to receive a threaded screw or bolt. The insert is pushed into a straight-sided, plain hole to provide female threads in non-structural parts at a cost reported to be less than one cent per hole. For quantities up to 1200 per hr., tooling consists of a mandrel which may be used in any device with a suitable stroke for pushing the insert into the hole (drill press, kick press, arbor press, air piston, and the like); for continuous large-volume applications, a hopper-fed automatic machine is available.

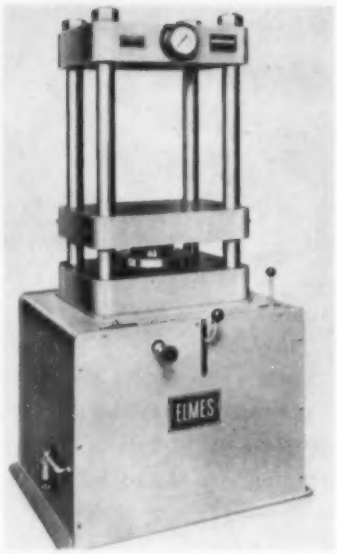
Pip inserts differ from standard inserts in several ways: 1) the Pip insert is tightly wound, 2) adjacent coils are in contact, 3) no driving tang is needed since the inserts are merely pushed into the holes, 4) the Pip insert has flat surfaces where the coils are in contact so that axial pressure will not cause the coils to slip over each other.

Pip push inserts are available as standard in copper-clad steel, but can be furnished in any material that can be formed into wire. *Heli-Coil Corp., Danbury, Conn.*

Hydraulic presses

Heretofore available only in 30- and 50-ton sizes, Hydrolair presses are now also being offered in capacities of 75 and 100 tons.

Hydrolair machines are true hydraulic presses which have neither motors nor pumps. Continuous high-pressure stroke is provided by a specially designed hydraulic intensifier, which is powered solely by compressed air (regular shop air in most installations). Preset pressures are maintained for any desired period without attention from operators. *American Steel Foundries, Elmes Engineering Div., 1150-B4 Tennessee Ave., Cincinnati 29, Ohio.*



Elmes' Hydrolair presses are now available in 30-, 50-, 75-, and 100-ton capacities

Static electricity meter

Portable electrostatic voltmeter detects and measures electrostatic charges on materials and equipment during processing. The instrument may be aimed like a pistol and will locate a charged area, give an indication of the amount of electrical charge on moving or stationary equipment or materials, and determine the polarity of the charge. *Custom Scientific Instruments, Inc., Kearny, N. J.*

Heaters

Addition of secondary insulation to a line of far infra-red electric radiant heaters permits their use in series on circuit potentials up to 600 volts. The heaters, designated Chromalox Metaray Lamp Replacement Elements, are equipped with a standard screw-base and final industrial application in drying, baking, curing, and dehydrating operations.

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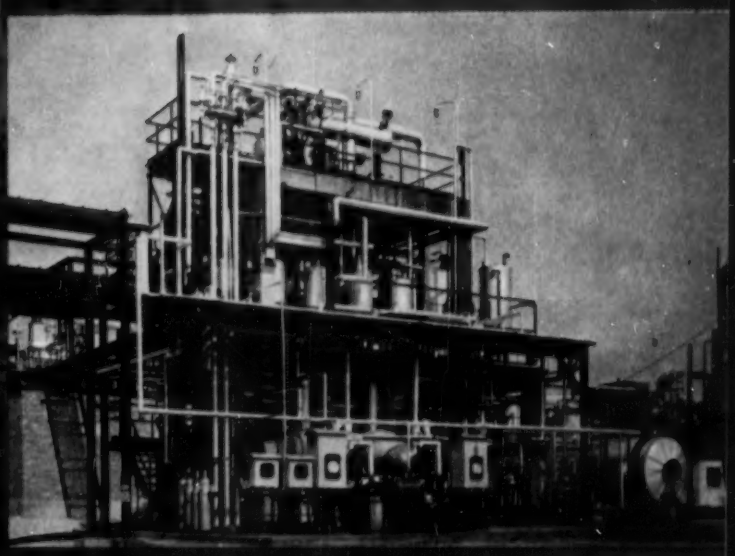

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Allied Chemical

Wiegand's infra-red heaters have standard bulb screw base

ture and resists breakage due to vibrations in severe industrial applications. Splashed liquids and other materials are burned off. The heaters are intended to replace conventional glass enclosed infra-red bulbs.

When used in automatic operations, heat requirements can be exactly matched to speed of conveyor and size of work. An input controller with a single adjustable dial control "meters out" the radiant infra-red heat to the level required.

The all-metal heat source is laid out in a Figure-8 pattern for uniform work coverage.

The heaters are interchangeable on conventional glass bulb infra-red equipment and are available in ratings from 375 to 1200 w. for 120- to 600-v. installations. *Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.*

Compression presses

A line of fully automatic, high-speed compression molding machines has been engineered in such a manner that, it is claimed, no technical expert is required to install and supervise the operation of the presses. The machines cycle automatically and continuously and require only the proper initial adjustment, occasional refilling with raw material, and removal of finished product. All operations are mechanical with the exception of mold heating, timing of curing cycle, and safety limit switches, which are operated electrically.

Disregarding the time required for curing, these presses are claimed to cycle completely in 3¾ sec., including feeding, closing, opening, and ejection.

During molding, the moving platen travels relatively fast towards the lower section of the press. Because a toggle mechanism is used, a considerable speed reduction occurs at the end of the stroke, allowing for the escape of accumulated gases, minimizing shock to mold, and reducing mold wear.

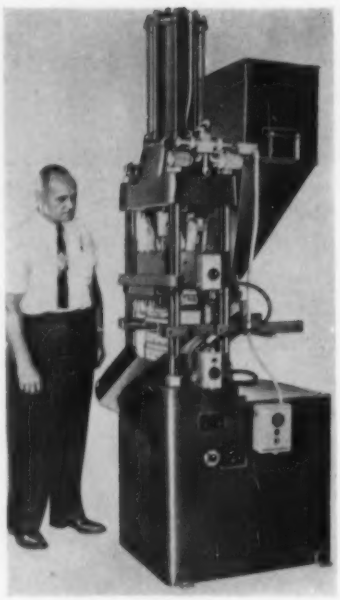
Any number of cavities may be used, providing the total does not require more than the 25- or 50-ton capacity, respectively. The feeding mechanism is cammed into the opening and closing of the press. Telescoping tubes predetermine the correct charge.

Ejection of parts from the presses is provided by lifters placed on the core side. Lifters raise the parts out of the cavity and above the lower half of the mold. By means of ejector pins the parts are then stripped from the cores and deposited on an inclined table whence they are sent to their respective bins. The inclined table is part of the feeding mechanism.

Two models are available in this line of presses, and their respective specifications are as follows:

Model A50	
Capacity (tons)	50
Platen area (in.)	14 by 6
Stroke (in.)	7¾
Ejection stroke	as required
Min. daylight (in.)	15
Max. daylight (in.)	19
Height (ft.)	9
Floor space (in.)	30 by 32
Air requirements (p.s.i.)	120

Model A25	
Capacity (tons)	25
Platen area (in.)	12 by 6
Stroke (in.)	6⅝
Ejection stroke	as required
Min. daylight (in.)	13
Max. daylight (in.)	15
Height (ft. bench mounted)	5
Floor space (in.)	30 by 30
Air requirements (p.s.i.)	120



Automatic Molding's compression presses cycle automatically and continuously without skilled supervision

The front-to-back platen area dimension of 6 in. given in the specifications is the width recommended by the manufacturer. However, greater widths can be successfully used if required. *Automatic Molding Machine Co., 3217 Exposition Pl., Los Angeles 18, Calif.*

Hydraulic presses

To meet the demand for processing at higher temperatures, a line of hydraulic presses from 20 to 125 tons is now available, on special order, with controls and insulation suitable for operation at temperatures up to 800° F. This entire line had previously been (and still is) available to operate in a temperature range up to 600° F. *Pasadena Hydraulics, Inc., 279 North Hill Ave., Pasadena 4, Calif.*

Router bit

Carbide-tipped cutting tool, designated 408-CT, performs a variety of finishing operations on high-pressure laminates. It can be used for flush-trimming, undercutting for self-edging, and bevel-trimming; however, it is not recommended for plunging operations. *Price & Rutzebeck, 22150 Meekland Ave., Hayward 72, Calif.*

2000-ton R. D. Wood Hydraulic Press for laminating and polishing plastics. Press has 10—4" openings, platen size 42"x83", and is of the completely self-contained type, including pumping unit for semi-automatic control of time, pressure and temperature. Press is equipped with hydraulic loading and unloading elevator. Send for complete details of this or other R. D. Wood presses for the plastics industry, without obligation

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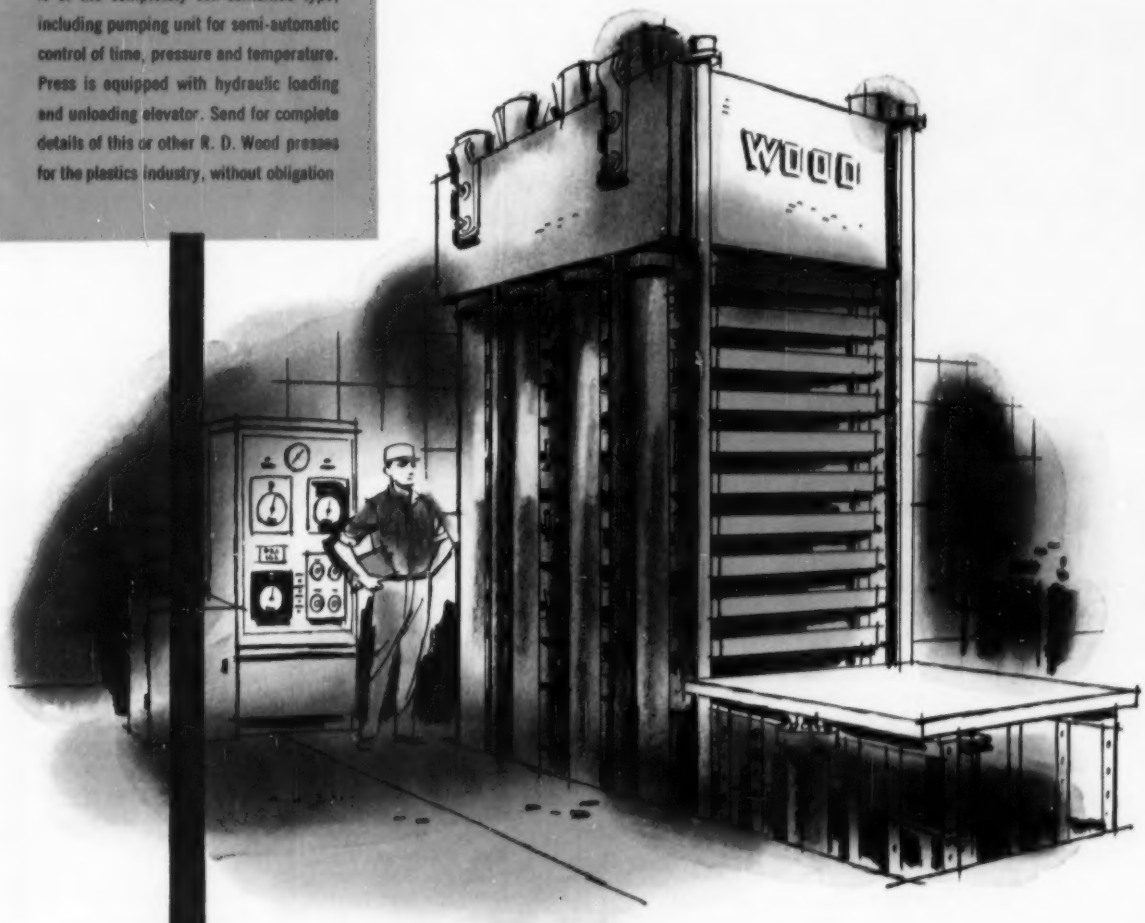

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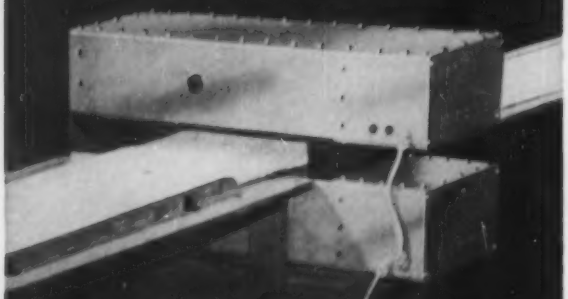

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Savings of thousands of dollars annually are reported in this installation at large plastics plant to protect molder dies.

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Duroid 5600 is a solution to other high temperature "problem" applications. Both flat gaskets and machined parts resist cold flow, heat distortion, and extrusion in continuous service up to 500°F., in intermittent service up to 600°F., and for short periods up to 750°F. Duroid 5600 fabricates easily and is readily blanked into parts with smooth, clean-cut edges.

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Books & Booklets

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationary.

"Safety in Industry"
by D. I. Macfarlane

Published in 1955 by Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. 17 pages. Price: $6.00.

Providing a general introduction to the subject of safety, the author briefly indicates means whereby workers can be protected from disease and accidents in industrial plants. Subjects covered are: dust and fume control; guarding rotating machinery; dermatitis; eye damage; radiation from X-ray and radioactive substances; types of protective clothing; and lighting and flooring.

Photographs and diagrams showing the results of neglecting simple precautions are included.

Color-guide book. A 29-page booklet, "Color Magic with Consoweld," offers illustrations and color charts which will help consumers to select appropriate patterns and colors in plastics surfacings to harmonize with any basic decorating scheme. $1.75. *Consoweld Corp., Wisconsin Rapids, Wis.*

Color calibration. Technical Bulletin No. 175 describes a system of color calibration for vinyl compounds. Migration, crocking, and uses and methods of application are discussed. In addition, charts listing properties and characteristics of a line of color pastes are included. *Claremont Pigment Dispersion Corp., 110 Wallabout St., Brooklyn 11, N. Y.*

Air Force film. A 26-min., 16-mm., sound and color motion picture, entitled "The Air Force Procurement-Production Story," explains how the Air Force buys aircraft and weapons system equipment. The film traces the procurement cycle from an aircraft's design status, through research, development, and production, to inclusion in the Air Force inventory. *Industrial Liaison Office (MCPAC), Directorate of Procurement and Production, Air Materiel Command, Wright Patterson Air Force Base, Ohio.*

Intensive mixers. Pamphlet entitled "Spiral Flow" describes a line of mixers and accessories for rubber and plastics. Advantages, specifications, sizes, and capacities are given, together with illustrations of the equipment. *Stewart Bolling & Co., Inc., 3190 E. 65th St., Cleveland 27, Ohio.*

Phenolic molding. Constituting a training course in miniature, this 16-mm., black and white, 20-min. sound film entitled "Molding Phenolics" gives a step-by-step presentation of successful phenolic molding. Every aspect, from first concept of the designer to the production of the finished piece itself, is covered. Methods of designing, building, and finishing molds for general and specialized articles are outlined in the first part of the film. Subsequent portions deal with basic phenolic molding processes, showing each process schematically and pointing out the advantages of each. Molding variables such as temperature, pressure, and time are discussed; specialized problems such as mold release, inserts, undercuts, and machining are mentioned; and information on how automation may be adapted to the phenolic molding cycle is presented. A manual accompanying the film offers a good starting point for questions and discussions following the showing of the film. The film is available to industrial, educational, and other interested organizations for group showings. *Technical Film Library, Bakelite Co., 292 Madison Ave., 10th Floor, New York 17, N. Y.*

Methyl n-propyl ketone. Technical Bulletin F-8780 describes physical properties, specifications, shipping data, and applications for methyl *n*-propyl ketone. Solvent data on resin solubilities and the performance of methyl *n*-propyl ketone in nitrocellulose lacquers are also included. *Carbide and Carbon Chemicals Co., 30 E. 42nd St., New York 17, N. Y.*

Consulting laboratories. Brochure discusses the relationship between independent consulting laboratories and industry, and answers typical questions often raised by prospective industrial clients. *Evans Research and Development Corp., 250 E. 43rd St., New York 17, N. Y.*

Chemicals catalog. Prices and properties of more than 400 chemicals, catalysts, accelerators, and cross-linking agents for the preparation of specialty polymers, developed for use in industrial and research laboratories in the field of polymerization, are listed. *The Borden Co., Chemical Div., Monomer-Polymer Dept., 511 Lancaster St., Leominster, Mass.*

Vulcanized fibre. Twenty-page brochure, "Vulcanized Fibre in Industry," describes how vulcanized fibre is made; its properties, methods of fabrication and forming, shapes and grades available, and representative applications in selected industries are also discussed. The forms this material can take—sheets, rolls, coils, rods, etc.—are listed. *National Vulcanized Fibre Co., 1055 Beech St., Wilmington 99, Del.*

Reinforced plastics. Twenty-page booklet P-SPRM(95.5) describes advantages, applications, and procedures for using "Scotchply" reinforced plastics in industrial fields, together with a discussion of machining and handling, molding, sanding and grinding, sawing, milling, shaping, turning, drilling, and tapping. In addition, it offers pricing information and charts describe the material's mechanical, electrical,

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chemical, and thermal properties. *"Scotchply" Reinforced Plastic Div., Minnesota Mining and Mfg. Co., 900 Fauquier Ave., St. Paul 6, Minn.*

Cellulosic cushioning materials. Report PB 111661 discusses the sorption of water vapor by cellulosic cushioning materials. Seven cellulosic materials were tested at 100° F. and 95% relative humidity. The experimental procedure is detailed and lists of tradenames and manufacturers of the materials tested are given, 50¢. *OTS, U. S. Dept. of Commerce, Washington 25, D. C.*

Catalysts. Twenty-four-page booklet, "Molybdenum Catalysts for Industry," discusses reactions which research and pilot-plant work indicate may be catalyzed by molybdenum compounds, as well as commercial processes—oxidation, hydrogenation, dehydrogenation, isomerization, cyclization, etc.—which are now using these catalysts. In addition, the booklet contains a table of typical reactions and conditions. *Climax Molybdenum Co., 500 Fifth Ave., New York 36, N. Y.*

Dispersions. Revised four-page pamphlet entitled "A List of 'Dag' Dispersions for Industry" lists 42 colloidal and semi-colloidal dispersions, including operational and mold-release lubricants for the plastics, glass, ceramic, and rubber industries. Graphite, molybdenum disulfide, mica, vermiculite, zinc oxide, and acetylene black are among the dispersions listed. Carriers and diluents, typical applications, and physical data are given for each product. *Acheson Colloids Co., Div. of Acheson Industries, Inc., Port Huron, Mich.*

Educational aids. Program kits, designed for presentation to an audience by any qualified individual in the field of engineering, contain: 1) a speakers manuscript, 2) visual aids (slides or film), and 3) up to 25 free copies of the program for distribution to the audience. The first program of the series, entitled "The Forces in Single Point Tool Metal Cutting," requires 42 min. delivery time and is illustrated with 2- by 2-in. colored slides. There is no charge for the use of the kits with the exception of return postage and insurance on the slides. Additional program copies (over and above the 25 complimentary copies) are available at cost. Additional programs are planned and will be announced as they become available. Requests for the kits should include time and place of showing, shipping instructions (allow at least 3 weeks delivery time), and the number of program copies. *National Program Committee, American Society of Tool Engineers, 10700 Puritan Ave., Detroit 38, Mich.*

Thermoplastic resins. "Exon Marks the Spot" is a folder which describes a line of thermoplastic resins. Properties and advantages of each are given. *Chemical Sales Div., Firestone Plastics Co., Box 690, Pottstown, Pa.*

Plastics and resins. A 12-page pamphlet, "1956 Condensed Reference File," presents technical data on phenolic, vinyl, styrene, polyethylene, fluorothene, polyester, silicone, and epoxy plastics and resins, and film and sheeting. Properties of the materials are presented and processing information is given. Typical products and uses of these materials are illustrated. *Bakelite Co., Div. of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N. Y.*

Pressure-sensitive tapes. The properties, specifications, and application data for a line of pressure-sensitive tapes are presented in a 25-page brochure. Tips on how to determine tape quality, and how to specify the proper tape for the job at hand are offered. Advantages and limitations are discussed. *Behr-Manning, Div. of Norton Co., Troy, N. Y.*

Venting fundamentals. Principles of venting flammable liquid storage and process tanks for effective operation, fire protection, and maintenance are described in the 12-page pamphlet "Venting Fundamentals." Specification sheets, engineering data, dimensions, and shipping weights useful in determining the proper type and size of equipment for most installations are included. *The Protectoseal Co., 1920 S. Western Ave., Chicago 8, Ill.*

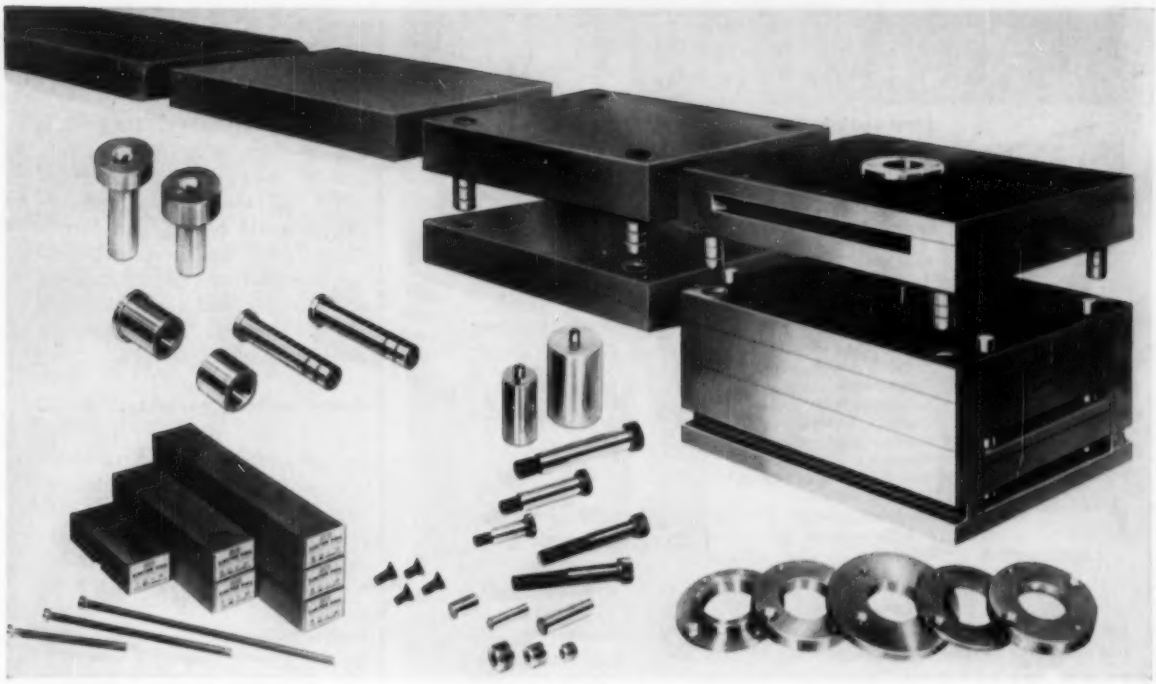
Adipic acid. Eight-page technical Bulletin I-12 covers the six basic reactions of the carboxyl group and 11 basic reactions of the alpha methylene group. It also includes suggested uses for this chemical. *National Aniline Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.*

Apparatus and equipment. Sixteen-page Digest No. 3 describes mobile air conditioners, liquid coolers, portable refrigeration systems, flexible heating tapes, interval and signal timers, stop watches, laboratory notebooks, pumps, needle valves, stainless steel laboratory vessels, and instruments. Sizes and prices are given. *A. Daigger & Co., 159 W. Kinzie Ave., Chicago 10, Ill.*

Industrial products. Fifty-two-page "Products Handbook" describes 11 lines of products for industry—insulations and refractory products; asbestos-cement pipe; packings and gaskets; electrical products; filter aids and mineral fillers; catalyst carriers and metal rings; synthetic silicates; friction materials; pipe protection materials; floorings; and roofing and sidings. Engineering data, methods of calculating heat transmission, tables on heat losses, and graphs on surface resistance are included. *Johns-Manville, 22 E. 40th St., New York 16, N. Y.*

V-belt drives. "Engineering Standards" manual offers data on sheaves and V-belts for drives, with particular attention to the duty to be performed. Formulas for ratings are given. $1.00. *Rubber Mfg.'s Assoc., Inc., 444 Madison Ave., New York 22, N. Y. or Multiple V-Belt Drive & Mechanical Power Transmission Assoc., 27 E. Monroe St., Chicago 3, Ill.*

Plastics service. Folder entitled "Custom Plastics Service" describes process of designing, printing, laminating, and fabricating flat and contoured plastics instruments, dials, calculators, etc., for the food, electrical, chemical, oil,



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steel, and other industries. *Allegheny Plastics Inc., Coraopolis, Pa.*

Polyvinyl chloride. Four data sheets—Nos. 75 to 78—describe a line of corrosion-resistant polyvinyl chloride plastisol coatings, unplasticized tubing, and plasticized linings and sheeting. Physical, chemical, and electrical properties, and typical applications are given. *Quelcor, Inc., Front & Broomall Sts., Chester, Pa.*

Compression molding. Four-page bulletin describes facilities for compression molding, inspection, and finishing for the electrical, mechanical, electronic, aircraft, automotive, and business machines fields. *Specialty Insulation Mfg. Co., Hoosick Falls, N. Y.*

Polyethylene. Two technical bulletins, C-5-224 and C-5-225, describe the application of Dylan polyethylene in various types of extruded pipes and piping and in injection molded pieces. Characteristics, properties, and molding techniques are given. *Chemical Div., Koppers Co., Inc., 1301 Koppers Bldg., Pittsburgh, Pa.*

Phenolic. General description, physical properties, cure conditions, and storage information concerning a modified phenolic low-pressure laminating prepreg with high-temperature resistance are given in two-page bulletin entitled "Mobaloy AH." *Mobile Plastics Div., Carlisle Corp. Mobile, Ala.*

Piping. Pamphlet entitled "Plastic Pipelines for the Petroleum Industry" describes four types of extruded plastics pipe—polyethylene, cellulose acetate butyrate, styrene-rubber bonded, and polyvinyl chloride. A chart listing suggested applications for each of the materials is included. *Petro-Plastic Engineering, Inc., 2811 Florence St., Dallas, Texas.*

Outdoor lighting. A 16-page booklet "Outdoor Lighting with Plexiglas" suggests methods of lighting large outdoor areas evenly. Quality of light, maintenance, safety, and appearance are discussed. Recent installations in

streets, tunnels, airports, bus terminals, plant areas, service stations, parking lots, and subways are illustrated. *Rohm & Haas Co., Washington Sq., Phila. 5, Pa.*

Laboratory supplies. A 12-page Catalog, D-1055, describes laboratory ware made of polyethylene. Sizes and prices of such products as jars, bottles, funnels, buckets, etc., are given. Sizes and prices for vinyl tubing are also included. *Palo Laboratory Supplies, Inc., 81 Reade St., New York 7, N. Y.*

Resins. Physical, chemical, and electrical properties of resin-rubber compounds, resins for reinforced plastics, polyvinyl chloride resins, and plasticizers for vinyl resins are listed and discussed in Condensed 1955-1956 Catalog. *Naugatuck Chemical, Div. of U. S. Rubber Co., Naugatuck, Conn.*

Exhaust systems. Pamphlet describes components necessary to fabricate and install a corrosion-proof industrial exhaust system. Characteristics and sizes of polyethylene seamless ducting, duct fittings, exhaust hoods, and fans are given. *American Agile Corp., P. O. Box 168, Bedford, Ohio.*

Packaging. Booklet entitled "1956 Guide to Improved Packaging" describes application of plastics film and coatings, molded and blown plastics, adhesives, and rigid sheets for both packaging and display. Polyethylene, phenolic, styrene, and vinyl plastics and resins are discussed. *Bakelite Co., Div. of Union Carbide and Carbon Corp. 30 E. 42nd St., N. Y. 17, N. Y.*

Polyethylene extrusion. Eight-page bulletin 19-DM describes polyethylene extrusion-laminating machinery. Three models of laminators are described and illustrated, along with accessories. Advantages, characteristics, and specifications are given for each. *Dilts Machine Works Div., Black-Clawson Co., Fulton, N. Y.*

Plastic deflashing. Equipment and operation of a deflashing process, in which moldings are enclosed in a cabinet-type machine and subjected to showers of soft-grit pellets hurled cen-

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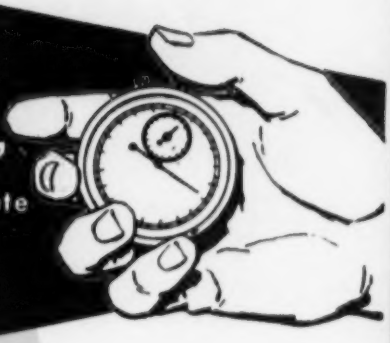

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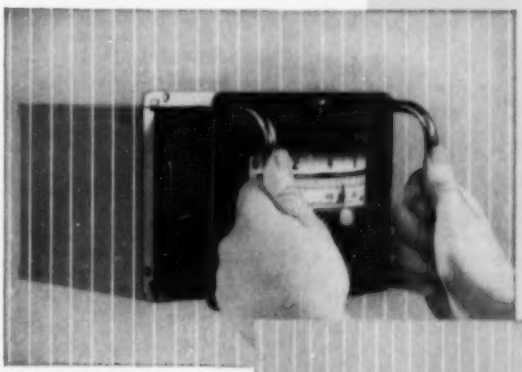

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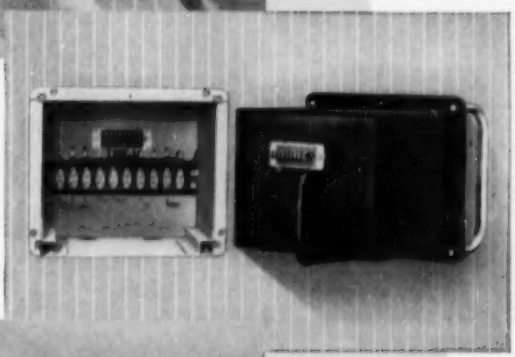

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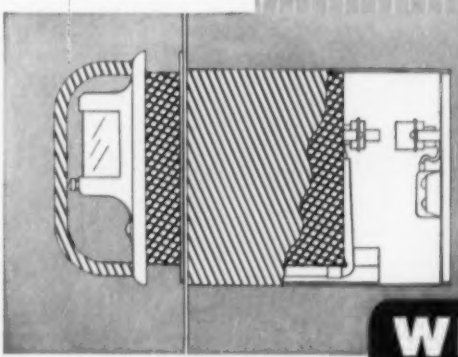

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trifugally upon them, is described in Bulletin PE-7. Case histories of typical products handled by this method are presented. *Wheelabrator Corp., Mishawaka, Ind.*

Engineering services. After differentiating between the engineering installation firm, the project engineering firm, and the engineering design firm, this booklet, entitled "A Guide for Selecting an Engineering Firm," lists the criteria for determining whether a given engineering staff is adequate to do a particular job. It then outlines guide posts for selecting an outside engineering firm and discusses what management can expect from the engineering firm which it hires, in the way of work output and time and money spent. In addition, case studies are given. *The Teller Co., Butler, Pa.*

Data folders. Information on phenolic and epoxy resins for users of plastic tools and dies, vacuum forming molds, etc., and phenolic and epoxy data folders containing pockets to hold catalogs, manuals, and technical literature are available. In addition, digests on these resins, their uses in casting, coating, sealing, laminating, etc., are in preparation. *Marblette Corp., 37-21 30th St., Long Island City 1, N. Y.*

Supervisory efficiency. The first issue of "Supervisory Management," a new monthly magazine, contains 60 to 70 pages of articles designed to improve supervisory efficiency. In addition to contributions from A.M.A. staff members and outside specialists, the magazine will publish appropriate material drawn from the American Management Association's meetings. The first issue covers such subjects as work sampling, grievance handling, production control, motivation of employees, the supervisor's role in community relations, and arbitration. Subsequent issues will stress information to help the foreman or supervisor in plant or office to do a better job. $6.50 per year (non-members $7.50). *American Management Association, 1515 Broadway, Times Square, New York 36, N. Y.*

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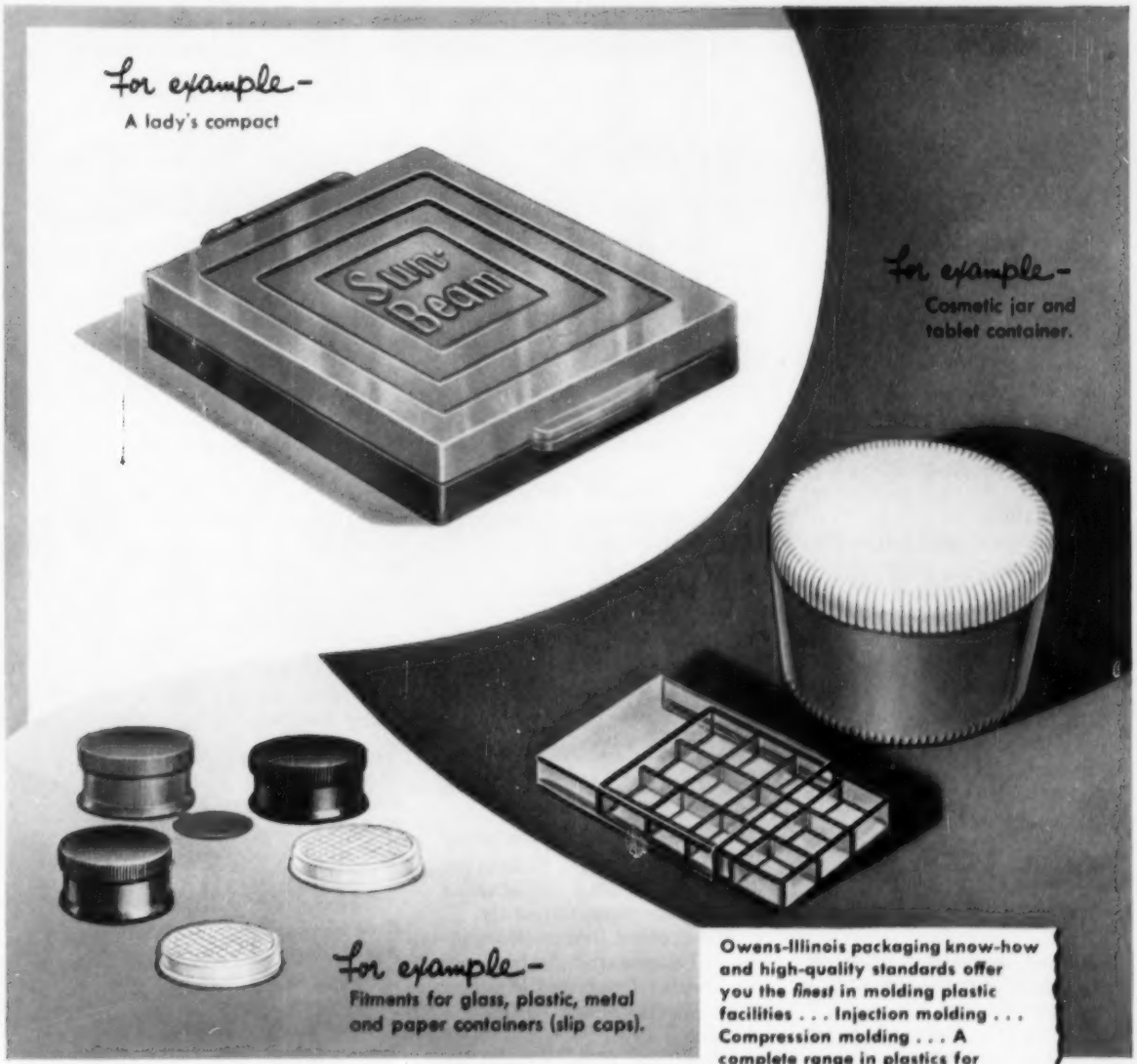

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Reinforced plastics conference

Program of exhibit and technical and management sessions

The Eleventh Annual Conference of The Reinforced Plastics Div. of the Society of the Plastics Industry, Inc. will be held February 7th through 9th, 1956 at Chalfonte-Haddon Hall, Atlantic City, N.J. Registration will begin 12:00 noon on Monday, February 6th, and will continue into Tuesday morning.

For employees and officers of S.P.I. member companies, registration fees will be $22.50 per person; for non-members, $32.50 per person; free for government representatives.

In conjunction with the conference, an exhibit of recent developments in reinforced plastics will be open to representatives from end-user industries.

Tuesday, February 7

9:30 A.M. to 12:00 Noon—Concurrent sessions on Strength-Time Behavior of Reinforced Plastics, Industrial Design, and Marketing and Management Forum.

Session I—Strength-Time Behavior

Presiding: R. H. Carey, Bakelite Co.

Recording secretary: Clare E. Bacon, Owens-Corning Fiberglas Corp.

Introductory remarks—Charles R. Stock, American Cyanamid Co.

"Introduction to Engineering Thinking and Concepts," Professor B. J. Lazan, University of Minnesota.

"Behavior of Glass-Fiber-Reinforced Plastics Laminates Under Long-Term Loads," K. H. Boller, Forest Products Laboratory.

"Creep Characteristics of Reinforced Plastics at Temperatures up to 500° F.," H. R. Sheppard and E. VanAntwerp, Westinghouse Electric Corp.

"Influence of Time and Temperature on the Mechanical Properties of Plastic Laminates," Norbert C. Meyers, Zenith Aircraft.

Session II—Industrial Design

Presiding: Hiram McCann, Modern Plastics Magazine.

Recording secretary: Richard H. Malamphy, Naugatuck Chemical.

"Human Engineering in Reinforced Plastics," J. McLeod Little, J. M. Little and Associates.

"The Designer and Materials," George Nelson, George Nelson Associates.

"The Industrial Designer and the Plastics Industry," George A. Beck, Electronics Div., G-E.

Session III—Marketing and Management Forum

Presiding: Harriet Raymond, Celanese Corp. of America, Plastics Div.

Recording secretary: John A. Owen, Consultant.

"Marketing Reinforced Plastics," James C. Bohlen, Lunn Laminates, Inc.

"An Analysis of the Marketing of Fibrous Glass Reinforced Structural Panels," William Egloff, Northwestern University.

"Management Responsibility for the Development of Engineers in the Field of Reinforced Plastics," G. G. Stamos, Zenith Aircraft.

"Setting up a Fiber Glass Reinforced Plastic Molding Plant and Organization," R. S. Morrison, Molded Fiber Glass Co.

12:30 to 2:30 P.M.—Luncheon

Welcoming Address: A. W. Levenhagen, Molded Fiber Glass Tray Co.

Principal Address: *"Directed Advertising,"* Edmund D. Kennedy, Manager, Advertising & Sales Promotion, Monsanto Chemical Co.

2:30 to 5:30 P.M.—Contact Period.

8:30 to 10:30 P.M.—Concurrent sessions on Strength-Time Behavior of Reinforced Plastics, Engineering Design, and Plastics for Tooling

Session I—Reinforced Plastics

Presiding: Ralph Sonneborn, Owens-Corning Fiberglas Corp.

Recording secretary: L. Stievator, Jr., McKesson & Robbins, Inc.

"Short-Time Creep as a Technique for Resin Evaluation in Reinforced Plastics," A. D. Coffeshall, General Electric Co., Materials & Processes Laboratory.

"Use of the Prot Accelerated Fatigue Test to Predict Endurance Limits of Plastics," L. S. Lazar, General Engineering Laboratory, General Electric Co.

"A Time-Temperature Dependent Modulus Test for Polyester Resins Used in the Field of Reinforced Plastics," J. R. Lawrence, A. L. Smith, and C. H. Weber, Rohm and Haas Co.

Session II—Engineering Design

Presiding: Robert J. Brinkema, R. J. Brinkema Co.

Recording secretary: Dan B. Hains, Consultant.

"Criteria for the Selection of Reinforced Plastics for Structural Applications," H. A. Perry, Jr., United States Naval Ordnance Laboratory.

"Laboratory Results Versus Serviceability for Reinforced Plastics in Automobiles," J. G. Coffin, General Motors Corp., Chevrolet Div.

"Adhesives for Fiber Glass Reinforced Plastics: A Specification Development Program," S. E. Yustein, N. Y. Naval Shipyard.

Session III—Plastics for Tooling

Presiding: Fred Lyijynen, Chrysler Automotive Body Div.

Recording secretary: Lawrence Wittman, Lawrence Wittman and Co.

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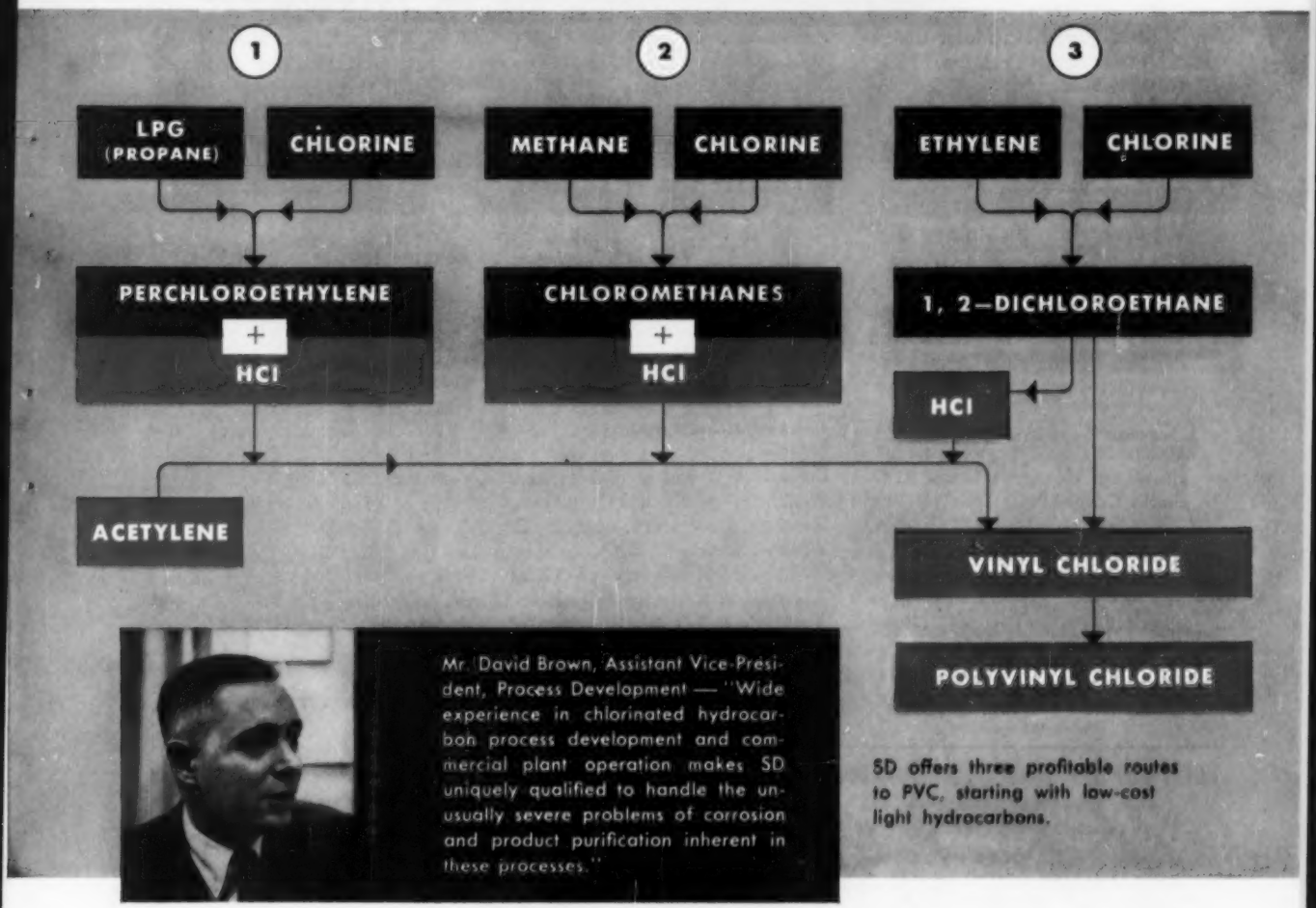
NEW DEVELOPMENTS



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For a large American chemical manufacturer, the answer to its captive needs and potential markets was a plant to produce chloromethanes (see method 2). This SD-designed plant, now in successful operation, is extremely flexible, producing methyl chloride, methylene chloride and chloroform in varying proportions as dictated by changing market conditions. Here again, the by-product HCl will be used in the synthesis of vinyl chloride monomer.

When ethylene is the available feedstock, SD offers still a third highly integrated route to vinyl chloride. Ethylene is chlorinated to form 1, 2-dichloroethane, which is pyrolytically cracked to yield vinyl chloride and HCl. The by-product HCl is then reacted with acetylene to produce more vinyl chloride.

These are examples of how SD cuts the costs and increases the profitability of new plant ventures by careful process integration and comprehensive evaluations of raw material sources and product markets. In new plant construction or the revamping of existing facilities to increase production efficiencies, SD's services are available on a confidential basis. Whether the project requires development of a new process, acquiring an existing process or engineering one of your own, you will profit by SD's specialized experience in organic chemical plant design.

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"Plastic Development Dies," E. Ruddiman, Ford Motor Co.

"Master Model Program," W. R. Weaver, Modern Pattern & Plastics, Inc.

"Reconciliation of Inner Models," Wallace A. Stanley, Studebaker-Packard Corp.

Wednesday, February 8

7:30 A.M.—Speakers' Breakfast

8:50 A.M. to 12:00 Noon—Concurrent sessions on Strength Time Behavior of Reinforced Plastics, Engineering Design, and Manufacturing.

Session I—Strength-Time Behavior

Presiding: George A. Stein, A. O. Smith Corp.

Recording secretary: Edward A. Jonasch, Jonasch Plastics Co.

"Effect of Time, Temperature, and Environment on the Mechanical Properties of Glass-Reinforced Thermosetting Plastics," Brandon B. Pussey, Bakelite Co.

"Molding-Finish Interactions in Fatigue of Glass-Reinforced Polyester Resins," R. C. Hooper, American Cyanamid Co.

"Analysis of the Long-Term Structural Strengths of Reinforced Plastic Pipe," H. D. Boggs, The Fibercast Corp.

"Load-Deflection Characteristics of Glass-Cloth Reinforced Plastics Under Conditions of Rapid Heating," J. H. Beno, E. F. Smith, and A. M. Dowell, Hughes Aircraft Co.

Summary Paper on Strength-Time Behavior Sessions: J. G. Coffin, General Motors Corp., Chevrolet Div.

Session II—Engineering Design

Presiding: Harry Sheppard, Westinghouse Electric Corp.

Recording secretary: Roger B. White, The Glastic Corp.

"Tensile Properties of Glass Fabric Laminates with Laminations Oriented in Any Way," Charles B. Norris and E. C. O. Erickson, Forest Products Lab.

"The Mechanics of Plastic Reinforcement," J. O. Outwater, Jr., M.I.T.

"Reinforced Plastics Springs," F. W. Reinhart, Leon Horn, D. A. George, and Sanford Newman, National Bureau of Standards, U.S. Dept. of Commerce.

"Elastic Constants of Oriented Glass Reinforced Plastics," Professor A. G. H. Dietz and Professor F. J. McGarry, M.I.T.

Session III—Manufacturing

Presiding: Julius Rosenwald III, Winner Mfg. Co.

Recording secretary: L. S. Meyer.

"Manufacturing of Panel Billboard Trim," C. L. Ward, Kimball Mfg. Corp.

"Matched-Die Molding of a 16-ft. Boat Hull," B. D. Raffel, Goodyear Aircraft Corp.

"Molding of Large Objects in Matched Metal Dies," R. L. Wiese, Molded Fiber Glass Body Co.

"Commercial Methods of Forming Balsa Cores for Thick Curved Reinforced Plastics Structures," Richard Mark, Balsa Ecuador Lumber Corp.

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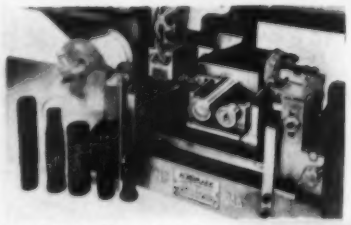

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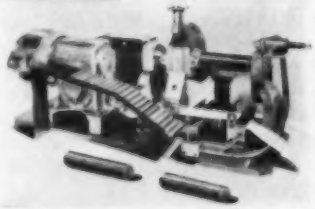

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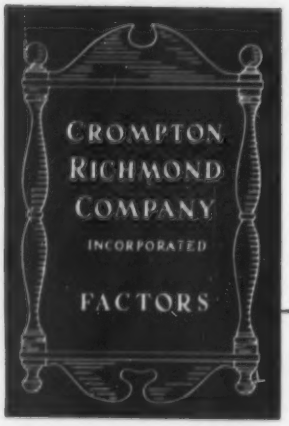

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lus Fabrics for Improved Mechanical Properties of Reinforced Plastics," J. Duflos, Pierre Genin & Cie., Paris, France.

12:30 to 2:30 P.M.—Luncheon
Presiding: W. Burdette Wilkins
Principal Address: *"Promoting New Products,"* A. M. Young, General Sales Promotion Manager, L-O-F Glass.

2:30 to 5:00 P.M.—Contact Period
8:30 to 10:30 P.M.—Concurrent sessions: Engineering Design, Process Session—Premix, and Materials and Equipment

Session I—Engineering Design

Presiding: I. M. Scott, Winner Mfg. Corp.
Recording secretary: Arthur J. Wiltshire, Apex Electrical.

"Moisture Vapor Transmission Through Glass Fiber Laminates," J. W. Case, Navy Bureau of Ordnance.

"Nondestructive Testing of Glass-Reinforced Plastic Laminates," Anthony J. Schwarber, Jr., Battelle Memorial Institute.

"Abrasion Resistance of Polyester Fiber Glass Laminates," Dr. Walter Brenner, East Coast Aeronautics, Inc.

"Factors Affecting the Design of Reinforced Plastics Aircraft and Missile Components," J. Marzicola, G. G. Stamos, Zenith Aircraft.

Session II—Premix

Presiding: Richard Capmen, Celanese Corp. of America.
Recording secretary: John Avignone, M. A. Cuming & Co.

"Premix Processing and Application," Richard F. Doyne, Thermaflow Chemical Corp.

"Large Scale Application of Premix Materials," A. M. Hansen, Chrysler Corp.

"Some Notes on the Properties of Premix Compounds," O. H. Pelham, Woodall Industries, Inc.

Session III—Materials and Equipment

Presiding: Samuel A. Moore, Interchemical Corp.
Recording secretary: W. E. Wirsch, Rohm and Haas Co.

"The S.P.I. Method of Measuring Light Transmission of Reinforced Plastic Panels," Raymond Meyer, Corrulux Div., The L-O-F Glass Fibers Co.; Daniel Smith, Interchemical Corp.

"Properties of Fibrous Asbestos in Reinforced Plastics Parts and Techniques in Fabrication," D. V. Rosato, Raybestos-Manhattan Inc.

"Properties of Wire Mesh Reinforced Epoxies," John Delmonte, Furane Plastics, Inc.

"Thermal Evaluation of Some New Thermosetting Resins," F. A. Yeoman and D. A. Rogers, Westinghouse Electric Corp.

"The Outlook for Reinforced Plastics in the Chemical Industry," D. G. Estey, Am. Cyanamid

Thursday, February 9

7:30 A.M.—Speakers' Breakfast
8:50 A.M. to 12:00 Noon—Concurrent sessions: Engineering Design, Cost and Safety, Process Session, and Transportation.

Session I—Engineering Design

Presiding: Irving Green, Zenith Aircraft. (*To page* 184)

HEAT V LIGHT

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ORGANIC 7-V-2

Epoxy assistant, highly effective HCl scrubbing agent, undiluted. Will extend stability for longer processing periods.

CADMIUM 28-V-2

For rigids, opaque to translucent. Stabilizes unplasticized resin efficiently and economically, with minimum effect on physical properties of product.

Stabilizing Systems developed for Harshaw Customers, for special processing and finished product properties, may contain one of the following stabilizers.

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CADMIUM 2-V-7: For modified solutions and organosols.
CADMIUM 24-V-1: Organic liquid complex for highest attainable clarity, used principally with dispersion resins.
CADMIUM 2-V-400: Modified 2-V-4.
CADMIUM 2-V-8: Selected laurate, used principally with low fusing resins.
BA-CD 12-V-9: Coprecipitated laurate.
CADMIUM 22-V-1: For rigid, clear and opaque stocks.
ORGANIC 7-V-1: Epoxy assistant.
ORGANIC 7-V-4: Epoxy assistant, for rigids.
BARIUM 1-V-3: Dispersible stearate, to contribute lubricity with barium effects.
BARIUM 1-V-6: For asbestos filled tile.
BARIUM 1-V-7: Liquid, for modified plastisols and organosols.
CALCIUM 5-V-1: Dispersible stearate, to contribute with calcium effects.
CALCIUM 5-V-22: Dispersible, low melting stearate to reduce internal friction.
ORGANIC 8-V-100: Modified 8-V-1.

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. . . so it doesn't matter that an elephant never forgets. The important thing is, busy businessmen, who *do* read MODERN PLASTICS, are apt to forget. They forget whose company was mentioned in that article they enjoyed so much . . . what the name of the product was . . . they even forget to clip the article to guard against forgetting.

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The best thing you can do is send out reprints. If an article appearing in MODERN PLASTICS concerned your company, product, or policies, have reprints made and get them into the hands of your prized customers, prospects, employees, salesmen and stockholders. These reprints are worth their weight in elephants.

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Recording secretary: John B. Alfers, Bureau of Ships, U.S. Dept. of the Navy.

"Evaluation of Reinforced Plastics Pipe," B. Kellam, The Hydro-Electric Power Commission of Ontario, Canada.

"The Effects of Certain Adverse Conditions on Glass Reinforced Plastics," Harry Pebly, Jr. and K. Carolan, Ordnance Corps, Picatinny Arsenal.

"Mechanical Properties of Glass Fabric Honeycomb Cores," Edward W. Kuenzi, Forest Products Laboratory.

"Comparative Operational Tests of Various Types of 40-ft. Utility Boats, Including Specific Test Data on Plastic, Steel, and Plywood Types" (to include a movie), Commander J. W. Nabb, Jr., U.S. Coast Guard, Washington, D.C.

"The Effects of Molding Techniques on the Long-Time Heat Resistance of Phenolic Laminates," J. D. Flynt, Cincinnati Testing and Research Laboratories.

Session II—Cost and Safety

Presiding: George L. Smead, The L-O-F Glass Fibers Co.

Recording secretary: James Lunn, Lunn Laminates, Inc.

"The Use of Organic Peroxides in the Reinforced Plastics Industry," C. H. Rybolt, Lucidol Div., Wallace & Tiernan, Inc.

"Plant Safety in the Reinforced Plastics Industry," Charles Shepherd, Corrulux Div., The L-O-F Glass Fibers Co.

"Estimating," Ned H. Porte, General American Transportation Corp.

"Cost Control and Cost Analysis," George L. Wright, A. T. Kearney & Co.

Session III—Process Session

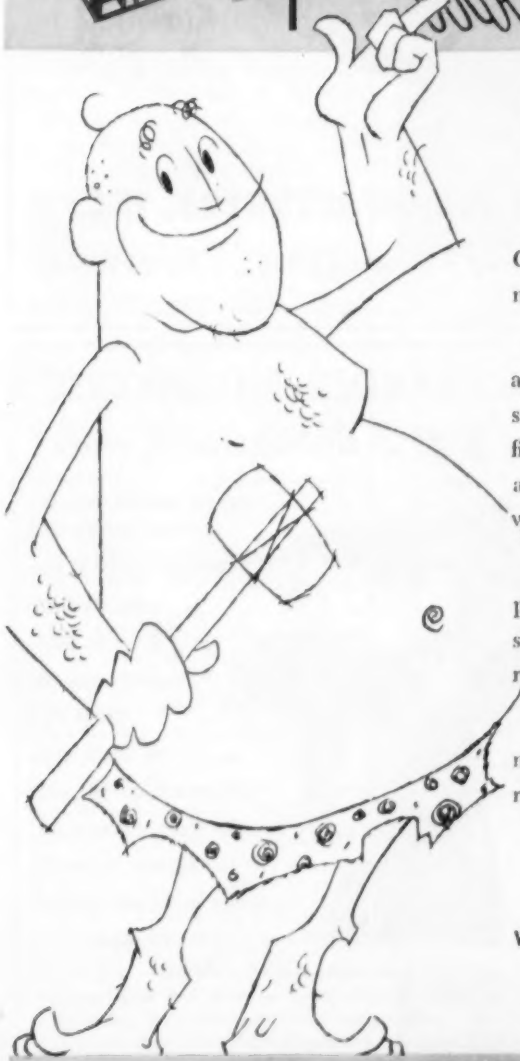
Presiding: Dennis Maxwell, Modigliani Glass Fibers Co.

Recording secretary: Cecil Armstrong, Armstrong Products Co.

"Degassing — for Improved Quality," Arthur L. Smith and John R. Lowry, Rohm & Haas Co.

"Post-Finishing Reinforced Plastics," Gene L. Leithauser, Research Laboratories Div., General Motors Corp.

"High-Speed Molding of Glass Reinforced Thermoplastics," J. A.



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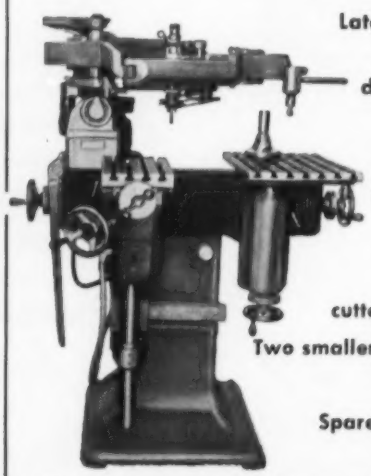

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Young, Owens-Corning Fiberglas Corp. (includes showing of a movie).

"Field Assembly of Reinforced Plastics Jettisonable Fuel Tanks," W. B. Fink, Zenith Aircraft.

Session IV—Transportation

Presiding: William G. Cole, Jr., Ferro Corp.

Recording secretary: Clare E. Bacon, Owens-Corning Fiberglas Corp.

"Current Status of Reinforced Plastics in Transportation," George K. Hammond, Owens-Corning Fiberglas Corp.

"Current Manufacturing Problems in Reinforced Plastics Components for the Transportation Industry," Semond Levitt, consulting engineer.

"Possible Use of Plastics in Railroad Equipment," R. E. Abbott, Association of American Railroads, Research Center.

12:30 to 2:00 P.M.—Luncheon

Presiding: I. M. Scott, Winner Mfg. Co.

Principal Address: *"The Outlook for Boats of Reinforced Plastics in the United States Navy,"* Captain Richard S. Mandelkorn, U.S. Dept. of the Navy, Bureau of Ships.

2:00 to 4:30 P.M.—Open Forum

Presiding: Robert J. Brinkema, R. J. Brinkema Co.

Recording secretary: Samuel S. Oleesky, Micronics, Inc.

6:00 P.M.—Reception

7:30 P.M.—Annual Banquet

Toastmaster: Samuel S. Oleesky, Micronics, Inc.

The following papers will not be delivered at the conference, but will be published in the preprint book of all papers to be given during the conference and which will be distributed to all registrants. The authors of the papers, however, will be available for the question-and-answer period at the open forum on Thursday, February 9th.

"Short-Time Creep Rupture Data Applied to Reinforced Plastic Missile Design," Lowell O. North, Narmco, Inc.

"Long-Term Creep Properties of Plastics Under Compression Loading," A. Rufolo and R. R. Winans, Material Laboratory, New York Naval Shipyard.

"Epoxy Resins in Reinforced

Typical reinforced plastic parts produced by Fabricon for the automotive industry

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	MP-106 (Sisal)	MP-162 (Glass)
Flexural Strength, psi	11,200—13,400	14,800—19,300
Modulus of Elasticity in flexure—10^6 psi	1.17 — 1.40	1.39 — 1.72
Izod Impact Strength, foot-pounds/inch of notch	4.2 — 5.4	6.3 — 8.3
Water Absorption, % 24 hr.	1.78 Average	0.69 Average
Heat Distortion Temp.	302°F. (+)	302°F. (+)

Above values based upon tests conducted by independent laboratories in accordance with ASTM methods. Compounds listed are latest of over 150 grades developed and produced by Fabricon. Sample test panels gladly furnished upon request.

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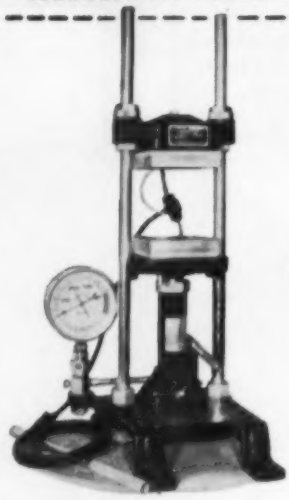

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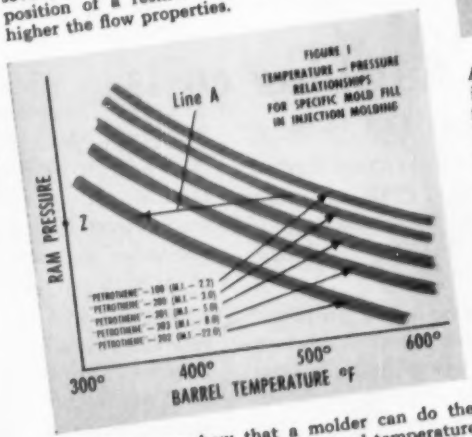
U.S.I. POLYETHYLENE PROCESSING TIPS

Increase production rates by choosing the right resin

Choice of the polyethylene resin with flow properties best suited for a particular application can make the difference between high or low profit to the injection molder.

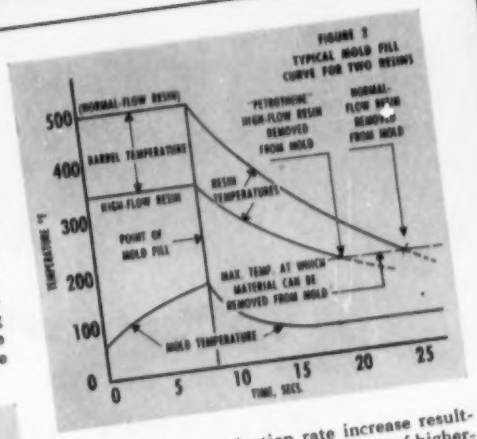
Which is the best resin? This of course will vary from application to application, but here is some background information that will help you find the right answer for your application.

The curved bands in Figure 1 represent injection molding conditions for resins exhibiting several different flow properties. The lower the position of a resin's band on the graph, the higher the flow properties.



These curves show that a molder can do the same molding job at a *lower* barrel temperature — without increasing his ram pressure — simply by going to a higher-flow resin. Line A, for example, shows that the job can be done at pressure Z with PETROTHENE® 200 at 500°F barrel temperature, can be done with PETROTHENE 201 at 470°F, PETROTHENE 203 at 430°F, or PETROTHENE 202 at 370°F.

What does this mean in terms of cycle time and production rates? Refer to Figure 2, which shows typical cooling curves for an injection molding cycle at two different barrel temperatures. The curve shows that the "normal-flow" resin, operating at a barrel temperature of 500°F in this particular mold, takes 25 seconds to reach release temperature, while the "high-flow" resin reaches this same temperature level in 21 seconds — a saving of about 16% in cycle time. Of course, these times and temperatures apply only to this particular mold. Other molds will have greater or lesser savings, but the same general principle applies.



Aside from the production rate increase resulting from this cut in cycle time, the use of higher-flow polyethylene resins has other advantages — 1. Higher surface sheen, 2. Lower warpage, 3. Less shrinkage.

One caution. When using high-flow resins, be sure that there is adequate back-pressure to eliminate the possibility of air voids appearing in the molded part.

Plant performance tells the story

Molders who have been using U.S.I.'s PETROTHENE 202 (Melt Index — 22) for molding large-size housewares report production increases of *as much as* 35%. Other high-flow types of U.S.I. PETROTHENE — types 201 and 203 — have been chosen because they give the desired degree of flexibility to the molded part, as well as for the production increase.

Call on U.S.I. technical service

Because there's no single answer to all molding and extrusion problems, each has to be tackled individually. U.S.I. Technical Service Engineers are ready to work with you toward the solution of any of your polyethylene processing problems.

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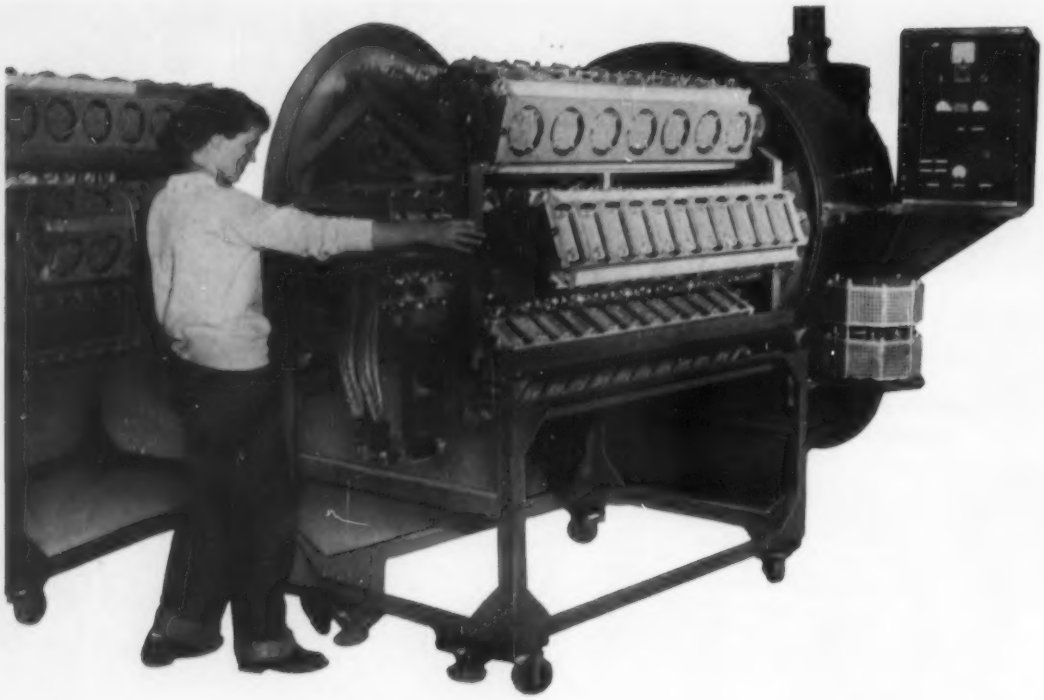

How to cut finishing costs

The finishing of plastic or metal pieces can be very profitable, *if you keep your process costs low.*

Vacuum metallizing with one of these *CVC* 48-inch vacuum coaters can cut costs to as little as a few cents per thousand. Here's why:

Large capacity: You can turn out thousands of pieces with this coater in a normal workday. High-capacity fixtures carry work for single-side or all-surface metallizing.

Versatility: Using lacquers and inexpensive aluminum, you can obtain literally hundreds of colored finishes.

Fast cycling: With *CVC*'s 48″ coater you can run two, three, or even four cycles an hour, depending on the base material used.

Simple operation: After a few hours' instruction, your personnel can turn out flawless coatings with this machine. A single operator simply inserts racks of lacquered pieces into the chamber, closes the "door," and initiates the pumping cycle. When the chamber pressure drops to the desired level, he evaporates the aluminum, which condenses immediately on the pieces. No buffing or polishing operations are required to turn out pieces with a mirror-like finish.

We'll be glad to share our long experience in vacuum metallizing and associated lacquering operations to help you set up your own coating system. Write for illustrated literature on the 48-inch coater and other *CVC* production units.

These rich-looking clock faces are inexpensive plastic coated with aluminum under high vacuum. Various lacquers provide a wide range of colored finishes.

A CVC vacuum coater enhances the beauty of pieces like this radio face, and gives the molder extra profits from the operation performed after molding.

A 30″ CVC vacuum coater turns out 550 of these amber-colored TV tuning knobs in one hour. You can metallize a wide variety of other sizes and shapes.

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Plastics," B. E. Godard, Bakelite.

"The Effect of Elevated Temperature on Triallyl-Cyanurate Glass Reinforced Plastics," Norman E. Wahl, Cornell Aeronautical Laboratory, Inc.

"The Use of Adhesives with Reinforced Plastics," Jerome L. Been and Martin M. Grover, Rubber and Asbestos Corp.

"Plastic Tooling—Recent Developments and Current Problems," Benjamin Sokol, Republic Aviation Corp.

"Formulators Service to the Tooling Industry," James A. Rengert, Automotive Body Div., Chrysler Corp.

"Tips on Aids for Body Die and Tool Construction," Ed Kalis and Werner Hamann, Fisher Body Div., General Motors Corp.

"An Introduction to Polyester Premix Molding," W. O. Erickson and W. R. Ahrberg, Glendale Plaskon Laboratory, Barrett Div., Allied Chemical & Dye Corp.

"The New Phenolic-Glass Fiber-Filled Molding Compound," Paul E. Fina, The Fibrite Corp.

"Case History of a Specialized Molding Material vs. Steel: The Plumb F-55 Hammer Handle," James L. Harvey, Plumb Chemical Corp.

"A Theoretical Consideration of the Influence of Peroxide Catalysts on Polyester Copolymerization Reactions," Dr. Russell T. Dean, Arthur Weber, John B. Crenshaw, Interchemical Corp.

"Experimental Diisocyanate-Based Laminating Resins," Samuel Polis, Naval Air Material Center, Naval Air Experimental Station, Aeronautical Materials Laboratory.

"The Effect of Kaolinite Particle Size on the Physical Properties of Mineral-Filled Polyester Laminates," W. R. Price, Jr., Georgia Kaolin Co. and Harry Raich, Jr., North American Fiberglass Corp.

"Reinforced Plastic Coatings for Wooden Boats," Walter L. Park, Puget Sound Naval Shipyard.

"Surface Finishing of Reinforced Plastics," C. M. Dunn, Jr., The Glidden Co.

"The Lost-Wax Process," Robert Kaufman, Zenith Aircraft.

"Fibrous Glass Pressure Membranes," H. S. Kraus, North American Aviation, Inc.—End

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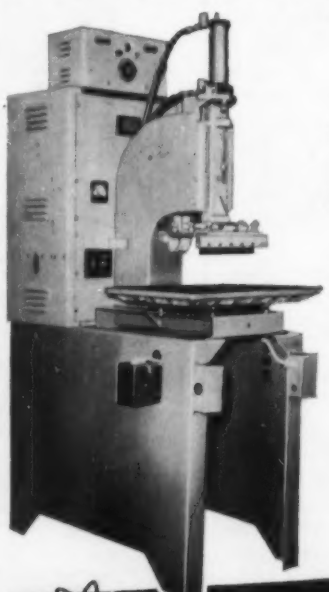

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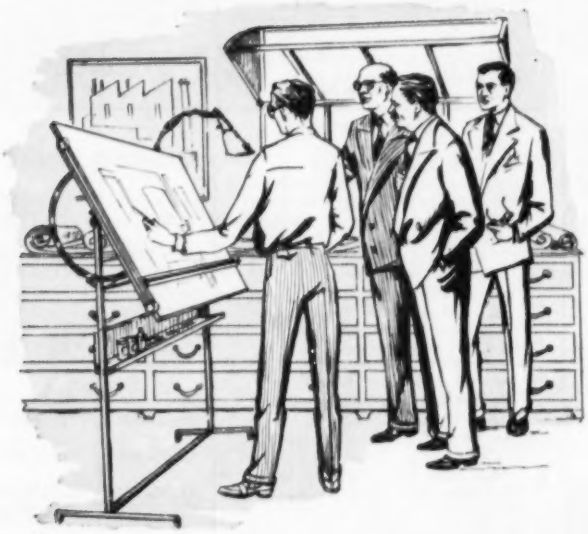

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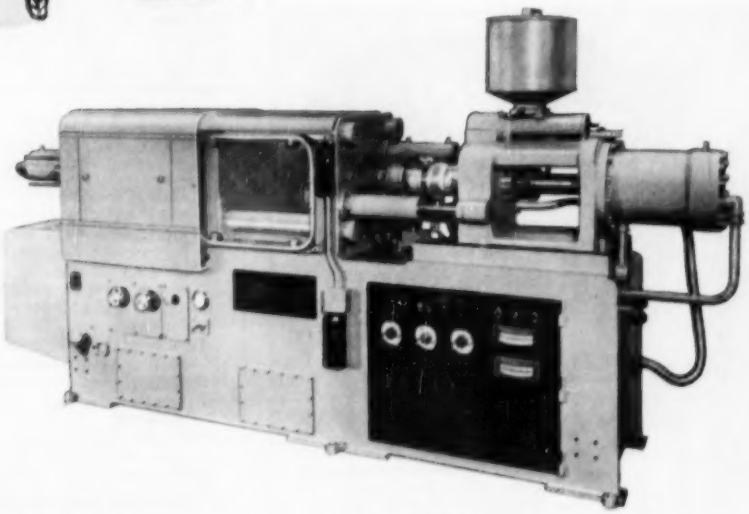

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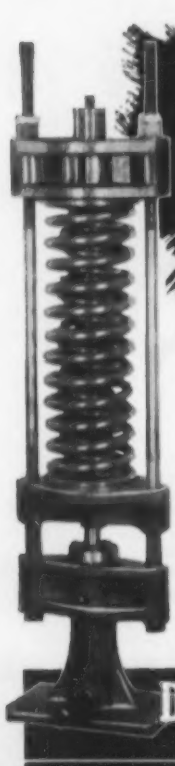

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mp Plastics

Production and sales figures in pounds* for September and October 1955

Materials	*Total p'd'n first 10 mos. 1955*	*Total sales first 10 mos. 1955*
Cellulose plastics:[c]		
Cellulose acetate and mixed ester		
Sheet, under 0.003 gage	15,669,875	15,710,047
Sheets, 0.003 gage and over	12,656,005	12,314,531
All other sheets, rods, tubes	6,440,017	5,983,028
Molding, extrusion materials	75,617,461	73,881,077
Nitrocellulose sheets, rods, tubes	3,989,879	4,152,019
Other cellulose plastics	4,793,255	4,421,491
Phenolic and other tar-acid resins:		
Molding materials[a]	173,592,805	161,428,417
Bonding and adhesive resins for:		
Laminating (except plywood)	53,330,985	42,074,968
Coated and bonded abrasives	38,957,793	29,877,258
Friction materials (brake linings, clutch facings, etc.)	21,193,004	19,122,591
Thermal insulation	41,490,743	41,630,519
Plywood	33,113,504	26,983,469
All other bonding uses	18,875,656	18,487,753
Protective-coating resins	21,825,770	20,769,907
Resins for all other uses	30,201,432	26,907,377
Urea and melamine resins:		
Textile-treating resins	34,171,636	33,136,123
Paper-treating resins	18,724,302	18,017,605
Bonding and adhesive resins for:		
Plywood	80,532,043	76,553,186
All other bonding and adhesive uses, including laminating	23,590,436	23,160,009
Protective-coating resins	31,736,710	24,589,553
Resins for all other uses, including molding	68,125,857	66,562,068
Styrene resins:		
Molding materials[a]	341,427,856	314,247,283
Protective-coating resins	82,556,936	76,771,445
Resins for all other uses	86,977,121	69,180,205
Vinyl resins, total[b]	574,598,831	536,576,883
Polyvinyl chloride and copolymer resins (50% or more polyvinyl chloride) for:		
Film (resin content)		70,149,288
Sheeting (resin content)		42,067,336
Molding and extrusion (resin content)		148,828,614
Textile and paper treating and coating (resin content)[c]		51,849,809
Flooring (resin content)		47,285,391
Protective coatings (resin content)		23,194,808
All other uses (resin content)		40,796,658
All other vinyl resins for:		
Adhesives (resin content)		26,673,209
All other uses (resin content)		88,731,769
Coumarone-indene and petroleum polymer resin:	216,528,413	215,687,387
Polyester resins:		
For reinforced plastics	42,064,003	35,880,476
For all other uses	2,772,028	2,584,131
Polyethylene resins:		
Miscellaneous:		
Molding materials[a,d]	126,215,029	97,576,673
Protective-coating resins[e]	3,714,616	2,212,321
Resins for all other uses[f]	82,393,117	81,345,113

* Dry basis designated unless otherwise specified.
** Partially estimated.
[a] Includes fillers, plasticizers, and extenders. [b] Production statistics by uses are not representative, as end use may not be known at the time of manufacture. Therefore, only statistics on total production are given. [c] Includes

Production

From statistics compiled by the U. S. Tariff Commission

*September***		*October***	
Production	*Sales*	*Production*	*Sales*
1,885,671	1,824,280	1,659,842	1,718,955
1,422,689	1,366,088	1,508,321	1,525,509
703,351	755,538	711,619	665,928
8,728,142	8,852,976	8,373,816	8,130,545
395,830	394,766	415,240	428,007
429,521	439,780	384,727	433,674
18,166,954	16,465,362	19,469,839	18,049,178
5,823,224	4,723,104	6,356,997	4,723,738
1,370,881	1,468,037	1,429,789	1,434,465
2,230,367	1,992,004	2,238,093	1,797,646
5,171,730	5,316,570	5,191,523	5,067,218
3,857,249	3,407,927	3,669,924	3,018,721
2,334,632	2,381,168	3,050,264	2,545,135
2,481,274	2,196,678	2,462,926	2,054,933
3,266,411	2,594,720	3,212,845	2,300,398
3,410,196	3,467,489	3,914,990	3,956,618
1,965,747	2,104,952	2,462,635	2,162,067
9,031,452	8,395,640	8,579,538	8,349,510
2,727,023	2,322,257	2,896,102	2,590,039
3,258,472	3,038,263	3,436,995	2,885,855
7,146,022	7,725,939	8,572,810	7,704,891
35,057,204	31,893,789	40,179,800	38,050,603
8,002,658	7,613,842	8,637,627	7,830,293
15,246,994	8,299,659	16,977,606	8,017,724
60,967,888	55,381,793	62,159,385	58,806,845
	6,982,807		7,498,482
	4,166,209		4,580,654
	15,412,328		16,064,421
	5,582,234		6,043,032
	4,707,365		5,456,551
	2,313,374		2,172,415
	4,016,903		4,485,425
	3,071,897		2,669,976
	9,128,676		9,835,889
23,599,090	23,748,913	23,471,156	22,971,739
3,803,282	4,010,947	3,630,604	3,312,141
289,239	188,338	231,194	100,948
37,214,859	30,613,517	39,208,150	34,616,537
4,541,205	4,243,482	4,857,554	4,443,228
381,485	233,562	351,711	194,076
6,873,682	6,476,407	8,025,279	7,326,799

data for spreader and calendering-type resins. [d] Includes data for acrylic, polyethylene, nylon, and other molding materials. [e] Includes data for epichlorohydrin, acrylic, polyester, silicone, and other protective-coating resins. [f] Includes data for acrylic rosin modifications, nylon, silicone, polyethylene, and other plastics and resins for miscellaneous uses.

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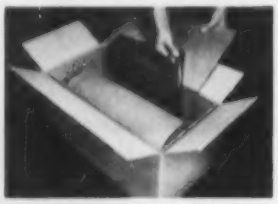

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Acrylic tanks

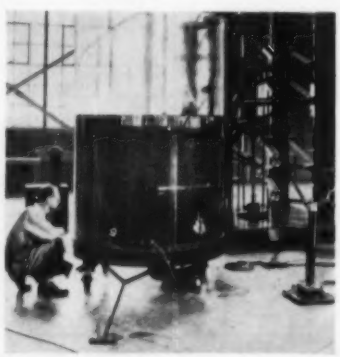
Transparency, excellent dielectric properties, and resistance to oils are the major factors in the selection of acrylic to replace steel for tanks used in transformer breakdown tests.

The steel vessels which were previously used to hold transformer oil in which prototype transformer coils were submerged, presented serious problems to the engineers: limited visibility made it difficult to detect exactly where and how breakdown was occurring; it was almost impossible to observe failure as it began to develop. Thus, exact voltage causing breakdown could not be determined.

A cylinder 5 ft. in diameter and 8 ft. high, formed of two ½-in. clear acrylic sheets, solved the problem. The bottom and side seams of the tank were butted and supported by reinforcing strips of the same acrylic material, and solvent-cemented to form tight joints. A circular steel base mounted on casters permits the tank to be positioned.

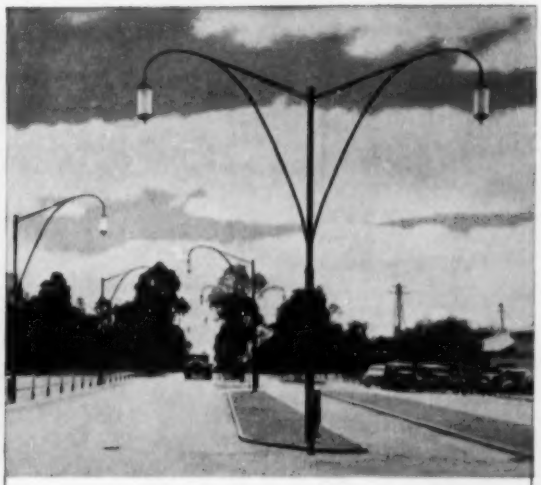
In use 800 gal. of transformer oil are pumped in, filling the tank to slightly more than half its height. Leads are introduced through the open top. Typical test currents imposed are 300 KV at 60 cycles for 1 min., and impulse voltages as high as 750 KV.

Credits: Acrylic tank designed by Packard Electric Co., St. Catherine, Ont., and fabricated by Crystal Glass & Plastic Ltd., Toronto, Canada, use Plexiglas sheet supplied by Rohm & Haas Co.



Coil undergoes breakdown test in acrylic tank

The luminous panels of a Montreal boardroom. Photograph by courtesy of Canadian Industries (1954) Ltd., Montreal.



'Perspex' street lighting fittings in Australia made by The General Electric Co. Ltd., London.

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'Perspex' ceiling light in an Italian bank. Photograph by courtesy of M. Adreani & Co., Milan.

'Perspex' street lighting fittings in Kuwait made by Siemens Electric Lamp and Supplies Ltd.

- ★ light in weight
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- ★ easy to fabricate

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Canadian enquiries to:
Canadian Industries (1954) Ltd., Plastics Dept., Box 10 Montreal, P.Q.

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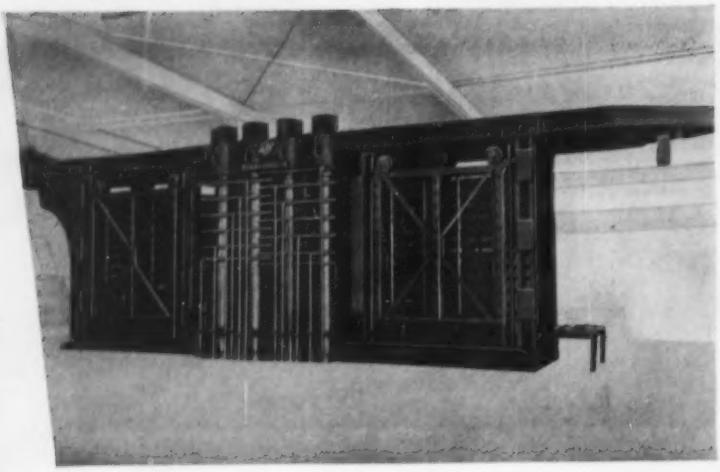

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Housing halves for two soldering gun models; molded-in vents vary with wattage rating. Trigger and switch housing is in center

Soldering gun handles

Wood flour-filled, nitrile rubber-bearing phenolic is being molded to provide more durable and resilient handles and transformer housings for a line of redesigned soldering guns. The addition of rubber to the previously used phenolic has contributed decidedly to the increased toughness of the material as well as to holding down production costs.

The new molded rubber-phenolic housings provide improved strength without increasing area or thickness of previous models. In the new designs, since constant use often causes transformers (particularly in the higher-wattage models) to heat to approximately 200° F., ample vent area was provided for adequate heat dissipation. A specially designed vent is molded into each half, and smaller openings are provided at various points along the parting line.

For the six models currently in production, three molds provide all the housings. For five of these models, two 2-cavity molds are mounted together in F. J. Stokes 200-ton hydraulic, toggle-actuated semi-automatic presses. Halves for the sixth—a low-cost, 100-w. model—are produced in a separate and smaller four-cavity mold. Housings for two of the models are interchangeable, as are also housings for three other models.

Guns can be assembled in 4 min., which includes peeling insulation from five wire connections, soldering two wires, assembling components (including trigger switch) into half of housing, covering with remaining half, driving three self-tapping screws, inserting tip, tightening nuts, testing, and boxing. All screw holes are molded in and self-tapping screws are used to ease the problem of locating nuts or ends of machine screws.

The rubber-phenolic molding compound, in addition to providing an extremely smooth feel due to the texture, keeps the over-all weight of the soldering gun to a minimum, makes flash removal easier, and can be molded at lower pressures. The company states, moreover, that actual field experience has determined that the molded portions stand up very well under repeated abuse.

Credits: Soldering gun handles and transformer housings are molded by Weller-Electric Corp., Easton, Pa., of Durez nitrile-rubber-bearing phenolic supplied by Durez Plastics and Chemicals, Inc., North Tonawanda, N. Y.

Molded rubber-phenolic housing for soldering gun has improved strength

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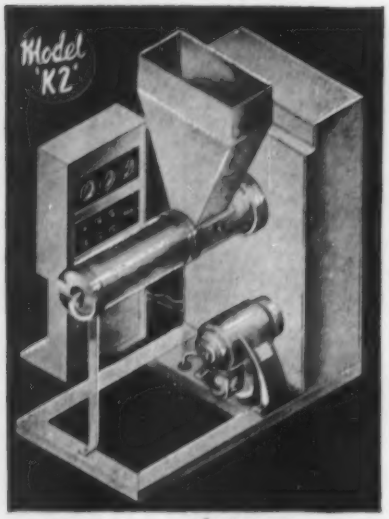

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Artist at work making mosaic of styrene pellets

Plastic in art

A new art medium looms on the horizon — styrene molding pellets.

In a technique developed by artist Jane Mueller, the pellets in a large range of colors are being used to create picturesque, textured mosaics. The mosaics may be complete in themselves or may be incorporated as part of an oil painting to highlight or emphasize certain colors or designs in the picture and to produce effects not readily obtainable with other art media.

When using the styrene pellets to create complete-in-themselves mosaics, the design (stylized as in traditional mosaic work) is first sketched on a canvas board, wood panel, or any smooth hard surface. The pellets are then placed in position, and bonded to the surface with china or wood cement.

When used to highlight or give texture to certain areas in an oil painting, the pellets are placed on top of the paint which has already been deposited on the canvas.

While this art technique is at present no more than an experimental effort, the possibilities are intriguing. The color range of styrene, the high luster of the material, the relative uniformity of pellet shapes, the ease of application, and the economy of the medium all suggest a potential market in the field of fine arts; and judging by the success of the recent numbered oil painting craze, do-it-yourself artists may constitute another fertile field.

Credit: Styrene pellets used by Jane Mueller supplied by Monsanto Chemical Co., Plastics Div.

6 WAYS TO GUARD YOUR HEART

1. AVOID SELF-DIAGNOSIS
In case of doubt see your doctor.

2. AVOID WORRY
Worrying cures or prevents nothing.

3. AVOID OVER-FATIGUE
When you rest or sleep, your heart's work load is lightened.

4. AVOID OVER-EXERTION
Exercise in moderation, particularly if over 40.

5. AVOID OVER-WEIGHT
Excess weight loads extra work on your heart.

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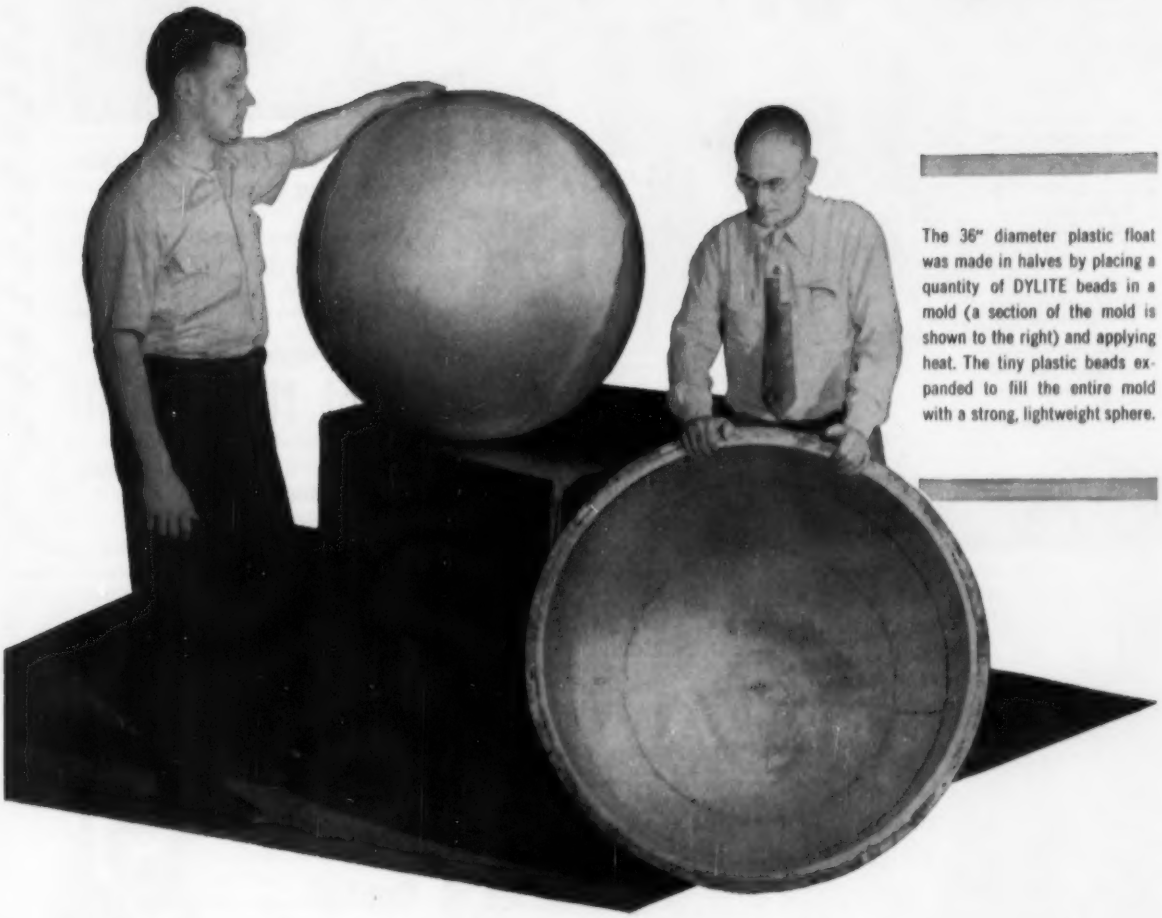

The 36" diameter plastic float was made in halves by placing a quantity of DYLITE beads in a mold (a section of the mold is shown to the right) and applying heat. The tiny plastic beads expanded to fill the entire mold with a strong, lightweight sphere.

The Navy needed a tough, lightweight float to support equipment weighing over 800 pounds. Additional requirements: the float must withstand a fall into the ocean, be easy to fabricate and float indefinitely.

After careful consideration, Navy scientists chose DYLITE expandable polystyrene for the float.

DYLITE, the new foamed plastic introduced 18 months ago by Koppers, has found many unusual applications. Tests have shown this extremely lightweight material ideal as a buoyancy agent. It is strong, waterproof, resilient, easy to mold into any shape required, is virtually unsinkable and low in cost.

For more information write to the Koppers Company, Inc., Chemical Division, Dept. MP-26, Pittsburgh 19, Pennsylvania.

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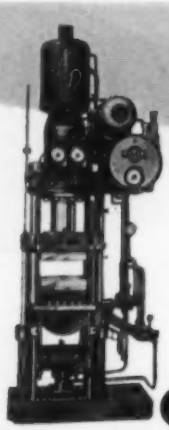
DANIELS

1



2

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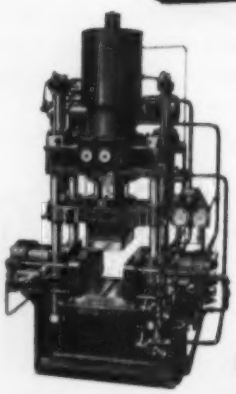

3

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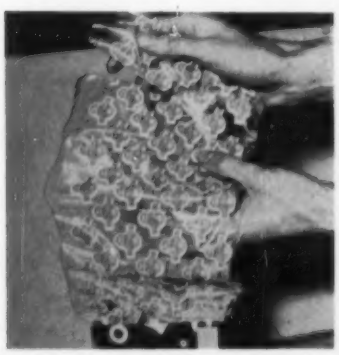
Strips of polyethylene film formed into individual, easy-to-separate pockets are providing for safe and more efficient handling of small industrial parts.

Filled pockets in the film strip are heat sealed in a single operation. When the strip package is folded together for shipment, it fits into a simple, uncompartmented carton, and two film walls of resilient polyethylene separate the contents of adjoining pockets, eliminating rattling and damage in shipment. The strip is easily lifted out of the carton; perforations in the film permit individual pockets to be torn off as needed.

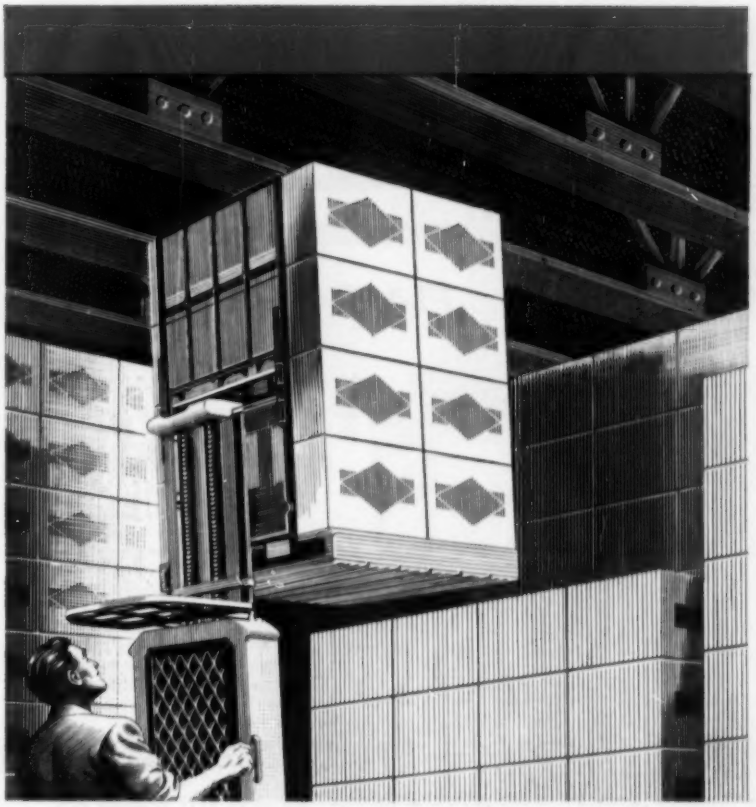
The film's resistance to moisture and abrasion protect small parts in storage as well as in shipment. Transparency of the film, and trademarks printed on it, permit immediate identification of the contents of each package as well as identification of the manufacturer. Unit structure of the package simplifies counting for shipment, inventory, and issuance of the industrial parts by both the distributor and user.

In addition to providing a quick visual count of stock, the new type package can be used to deliver all the necessary parts for the assembly of a single unit of a product in proper sequence.

Credits: Developed by Austin Industries, Inc., Marlboro, Mass., the new materials handling package is used by Bay State Abrasive Products Co., Westboro, Mass.; polyethylene is supplied by Bakelite Co.



Small parts are easily handled in convenient pockets



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Open space under your warehouse roof may be clear profit... if you can utilize it by stacking boxes taller. But, before you do, be sure your boxes will stand straight and strong under the increased load. Gaylord containers have this valuable "stack-ability" because they are precision built of the finest quality materials.

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PLASTIC GRANULATOR

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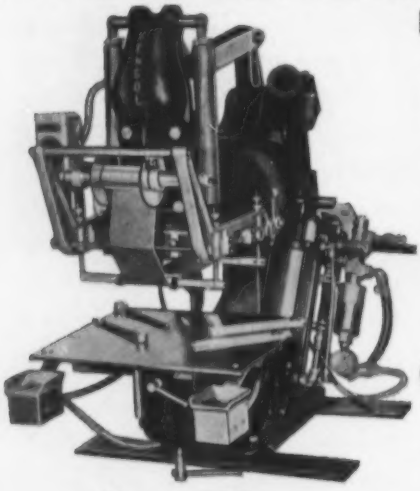

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Using nylon bristles, spool holder prevents snarling of yarn in manufacturing hose

Spool holder

Paper-base phenolic laminate spool holders utilizing nylon "cat's whiskers" are eliminating kinks and snarls in yarns used in the manufacture of "stretch" type hosiery.

To produce "stretch" hose, the knitting machines first make two courses with yarn of one twist, then two more with yarn of an opposite twist. This reversal is repeated until the hose is completed. One yarn carrier, therefore, rotates for two courses and stops; yarn for the next two courses is then drawn off the other spool. Frequently this brief periodic stopping of the carrier causes a slackening of tension and the stretch yarn, relieved of tension, kinks or tangles.

To avoid this, the phenolic package holder has a set of nylon bristles arranged like cat's whiskers around the top end of the spool. As the yarn is unreeled, it is held lightly against the end of the spool by the free end of one of the nylon bristles. This tension prevents the yarn from coiling up and kinking when the carrier stops.

A spring clamp in the center of the cylinder base, made of a post-formed cloth-base phenolic, holds the bobbin or spool of stretch yarn in place, permitting the usual 1½- to 2-in. diameter spools to be mounted. A cap prevents the yarn from rubbing against the end of the spool.

Credits: Phenolic spool holder made by Synthane Corp., Oaks, Pa.

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And—it's economical to produce—because it's custom molded, in one operation, of fiberglass-reinforced plastic—by Molded Fiberglass Company.

In other words, this projection horn has been made *better* with Molded Fiberglass.

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Closure strips

Resilient vinyl closure strips that can be fastened by nails, bolts, or screws are being used as end seals on installations of corrugated reinforced plastics sheets in such applications as shower stalls, porch roofs, greenhouses, walls, room dividers, etc.

Available for use in both horizontal and vertical strips in standard 2½- by ½-in. corrugations, the material is soft enough to form a water-tight and air-tight seal with any corrugated sheet material, yet, because of its mechanical strength, can take rough handling during installation. In addition, the closure strips are unaffected by climatic conditions and automatically adjust to slight expansion and contraction in structural materials. Their flexibility is maintained at temperatures as low as 0° F., and it is claimed that they can be successfully used at temperatures as low as −40° F. They are unaffected by acids, alkalies, oil, grease, and gasoline, as well as by water, rain, and snow.

The horizontal strips are produced in sections 34⅔ in. long; the vertical strips are 36 in. long. Colors which match most of the corrugated materials with which they are used—coral, light blue, yellow, light and dark green, ivory, and white—are molded into the material.

Credits: Molded of Bakelite vinyl resins, corrugated plastic closures are produced by Hanszen Plastics Co., 835 S. Good-Latimer Expressway, Dallas 10, Texas.

Molded vinyl closures used to seal corrugated sheet

making a

MARKED IMPROVEMENT

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The problem of paper labels on cans becoming dirty and torn (and presenting a poor sales appearance on the retailer's shelf) plagued a typical paint manufacturer, until he began using the Markem Method. Now he's imprinting variable data (color, batch number, etc.) on 1500 lithographed cans per hour with a Markem 70AF machine. Changing imprint simply means sliding new type into the master-plate (instead of ordering 2000 new labels). Whether it's a container, product, part or tag you're marking—for decoration, designation or identification—ask Markem. Thousands have, for the past 40 years. Write Markem Machine Co., Keene 20, New Hampshire.

Markem ...TO MAKE YOUR MARK

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. . . and it's easy to see why, because CINCINNATI Monoset Cutter and Tool Grinders are completely universal . . . you can accurately grind any shape desired. Three typical examples are illustrated below. ¶The Monoset is tops for re-sharpening jobs; for salvaging broken cutters; for making cutters from solid bar stock. Here are the pay-off features of Monoset:

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3) Micrometer dials and stops for all slides
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These and other Monoset features mean accurate, low-cost cutters that produce smoother, more accurate contours in molds and hobs. Every tool and die shop needs a CINCINNATI Monoset. You will find brief specifications in Sweet's Machine Tool Catalog. Complete information in our catalog No. M-1591-1.

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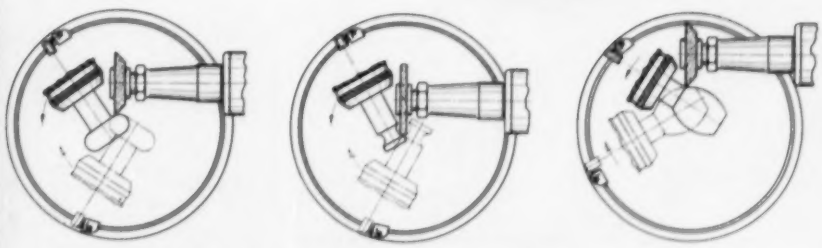
Grinding the flutes at the end of a ball nose die sinking cutter, on a CINCINNATI Monoset Cutter and Tool Grinder.

CINCINNATI Monoset Cutter and Tool Grinder. Write for catalog No. M-1591-1.



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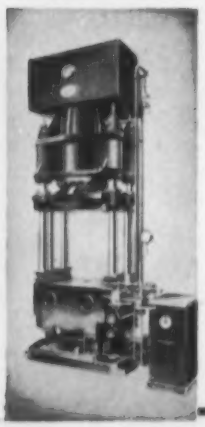

Press Button Control —fewer rejects!

This completely self-contained press with automatic control virtually eliminates operator error. Consistent molding quality is assured. It's No. 984, one of the many presses listed in the B. & T. Catalog.

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New Sarcotrol Unit automatically maintains uniform roll temperatures

Temperature variations across the faces of water-jacketed cylinders . . . so often the cause of production slow-downs because of product imperfections . . . can now be completely eliminated with this new Sarcotrol Heating and Cooling Unit.

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Sarcotrol Heating and Cooling Unit available with 1, 2 or 3 independent circulating water systems.

Operation is simple and entirely automatic. One knob changes temperature control setting. Controlled temperature is continuously indicated on easy-to-read dial.

Write today for Case History 154 describing how a leading plastics firm increased production after installing a Sarcotrol on chill rolls. 2093F

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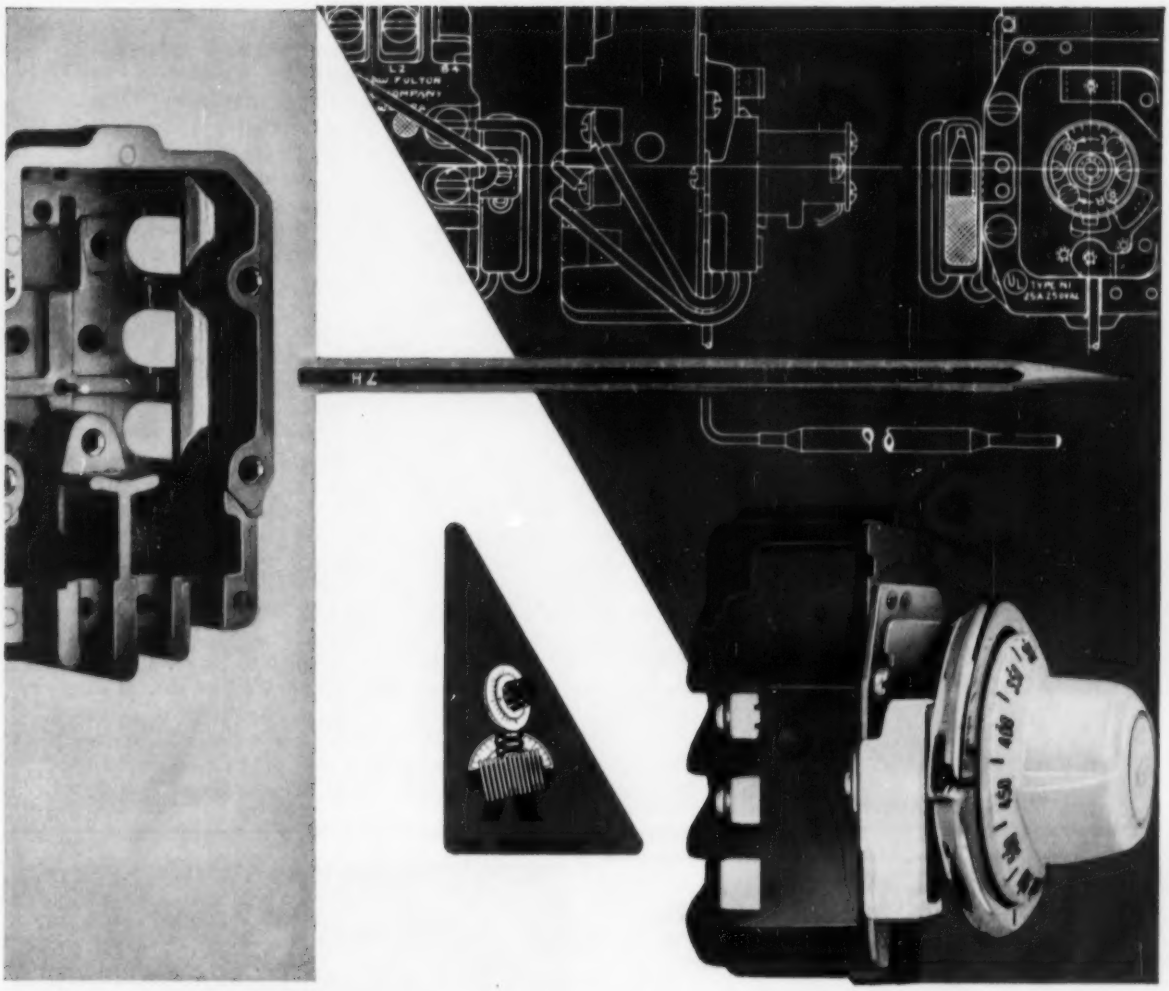

it's DURITE for Robertshaw-Fulton thermostats

Parts molded for a leading manufacturer of appliance controls like the Robertshaw-Fulton Controls Company must be easy to machine and finish . . . and have the dimensional stability so essential to perfect assembly and trouble-free service life. In addition, they must have good heat resistance and electrical properties.

That's why Robertshaw engineers, after consulting with their molder, Kurz-Kasch Inc., chose Durite GP-151 phenolic molding compound for the housing of Robertshaw's oven thermostat shown here.

The batch to batch uniformity of GP-151 is a primary reason for its popularity among leading molders. Its production is carefully controlled—from selected raw materials to the finished compound. Result: uniformity in every molded part.

"MR. CONTROLS" is a registered trademark of the Robertshaw-Fulton Controls Company.

You will find Durite GP-151 an ideal general purpose molding compound for parts that are large or small, intricate or simple, thin-walled or heavy-sectioned. Why not let us prove its value to *your* operation with a trial run? Contact The Borden Company, Chemical Division, Durite Products Dept., MP-26, 5000 Summerdale Avenue, Philadelphia 24, Pa.

DURITE

THE Borden COMPANY

CHEMICAL DIVISION

Phenolic Molding Compounds • Abrasive and Frictional Bonding Resins • Molding and Specialty Resins • Lamp Basing Cements

What's new

(*From pp. 81-86*)

on some of the newer laminating resins, application is expected to expand. As reported by The Garlock Packing Co., for example, when working with silicones, glass is one of the few materials that will stand the high temperature applications (up to 500° F.) for which the silicones are most suited. Epoxy-glass base laminates for printed circuits are also increasing in application by virtue of their strength, excellent electrical characteristics, and ease of machining.

Also of interest to the high-pressure field are synthetic papers based on glass fabrics. Libbey-Owens-Ford Glass Co., Fiber Glass Div., one of the companies supplying microfibers (very thin filaments with diameters as small as 3½ microns) for this application, reports that paper based on 100% glass construction shows good electric properties; in most cases, better than glass fabrics. It is also reported that the papers can be used in low-pressure laminates for electrical uses as an interlayer between lay-ups of cloth or mat.

Glass paper is also available from American Machine & Foundry Co. This company's product, "Tissuglas," is essentially glass microfibers to which a binder and/or impregnation can be added to achieve desired electrical, chemical, or thermal properties. The paper is available in thicknesses ranging from 0.5 to 13 mils and in widths up to 40 inches. The plain glass paper can be as much as 95% air by volume. Wet strength is approximately 70% of dry tensile which ranges from 95 to 880 p.s.i.; breaking strength varies from 200 to 1350 g. per in. of width. Potential applications include surfacing sheets for high- and low-pressure laminates.

Although it is still too new to evaluate the glass papers, their major application would appear to be in those areas where the desire for certain characteristics offsets the added cost.

Molding compounds: In premix or "gunk" formulations, fiber reinforcements may be vegetable (sisal), synthetic, or mineral (glass), depending on the end properties desired. Sisal and glass right now are prime materials in the field. Glass, of course, is the more expensive of the two, but it offers higher strength and greater rigidity than sisal fibers. Also, when low moisture absorption and retention of a painted finish are factors, the glass reinforced material is preferred.

The range of applications for reinforced molding compounds covers a lot of ground, depending on what resin is being used. Glass-reinforced alkyd, for example, has been used to mold a miniature synchro unit for aircraft control systems; a glass-reinforced polyester has been used to mold non-magnetic, sturdy, dimensionally stable clock housings for business machines; a glass-reinforced phenolic has been used for molding a compact instrument box for the U. S. Army Signal Corps that can be safely dropped

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Air-Operated—¼-ounce Capacity

INJECTION PRESS

Gives up to 225 cycles per hour

Ideal for—

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The Model A-2 illustrated handles conventional thermoplastic molding materials.

Power-Pak air cylinder operates from 100-125 PSI air line.

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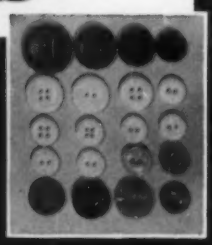

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- COMES IN 3 SIZES

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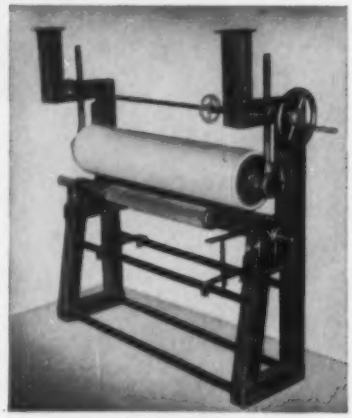
. . . Such FLEXIBILITY . . . Such QUALITY in a low cost one color print machine

Field reports from users of the Liberty Single Color Production Print Machine for plastic films confirm our most enthusiastic expectations:

- "We like the idea of having a clear view of both the doctor blade and the cylinder at all times."
- "When printing from the doctor, we can start running with only a pint of ink; two or three quarts do the trick when using the ink pan."
- ". . . never seen a machine where coppers could be changed so quickly. Appreciate not having to remove the coppers to wash them up."



All steel construction. Ball bearing throughout. Widths from 48" to 72" face. To 24" repeat.

Now about price: Liberty does not believe a machine with equivalent features, doing comparable printing, is available anywhere at less than twice the price. We will gladly supply full details. LIBERTY MACHINE CO., INC., 275 Fourth Avenue, Paterson 4, New Jersey.

LIBERTY MACHINE CO., INC.

Write for Liberty's new catalog. It describes all Liberty machines.

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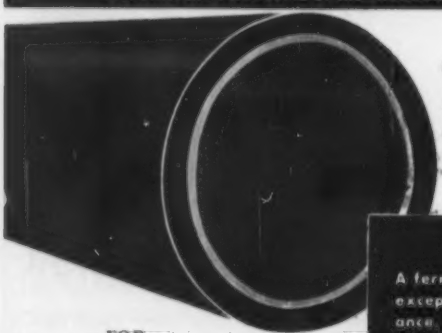
MEETING the PROBLEMS of the RUBBER-PLASTICS INDUSTRIES



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from a plane with only a small parachute to cushion the shock of hitting the ground; glass-reinforced styrene compounds are used for such diverse applications as film reels, slide viewer housings, and fans for automobile heaters; and glass-reinforced melamine is being used in the manufacture of electrical products.

Non-fibrous forms

Developments in non-fibrous glass forms of reinforcements have moved along at a slower pace than the glass fibers. Two such variations were introduced only last year and are still largely in the experimental stage.

One of these, a development of Owens-Corning, consists of tiny flakes of film glass furnished in bulk form. The flakes are created by blowing a tube or bubble of glass 0.0001 to 0.0002 in. thick and then shattering it. The material is still too new for evaluation, but Owens-Corning sees its eventual use in premixes, in casting, and, when used in conjunction with cloth and mat, in laminating. Experiments have also been conducted on milling the flakes into resin and extruding the batch in the form of wire coating or corrugated sheeting.

Another development in the glass field is unicellular spherulized particles—literally, tiny hollow glass balls. They are produced in mesh sizes from 20 to 100 by Ferro Corp., and have a particle density of 0.4 to 1.6 g./cc. and a bulk density of 20 to 35 lb./cu. foot. The makers stress the point that this material is not to be considered as a filler for reinforced plastics, but is in itself a reinforcement with exceptionally good electrical properties and compressive strength. The spherical reinforcements can be used with epoxy and polyester resins in encapsulation and in tooling for the metal forming industries.

Synthetic fibers

Until recently, activity of the synthetic fibers in laminates and molding has been relatively limited (nylon has been about the only one used to any commercial extent), but the pace has picked up in the past few months.

As a class, synthetic fibers, be-

NOW—improve your molding production!

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SERIES M
MOLDING MACHINES

- IMPROVED DESIGN
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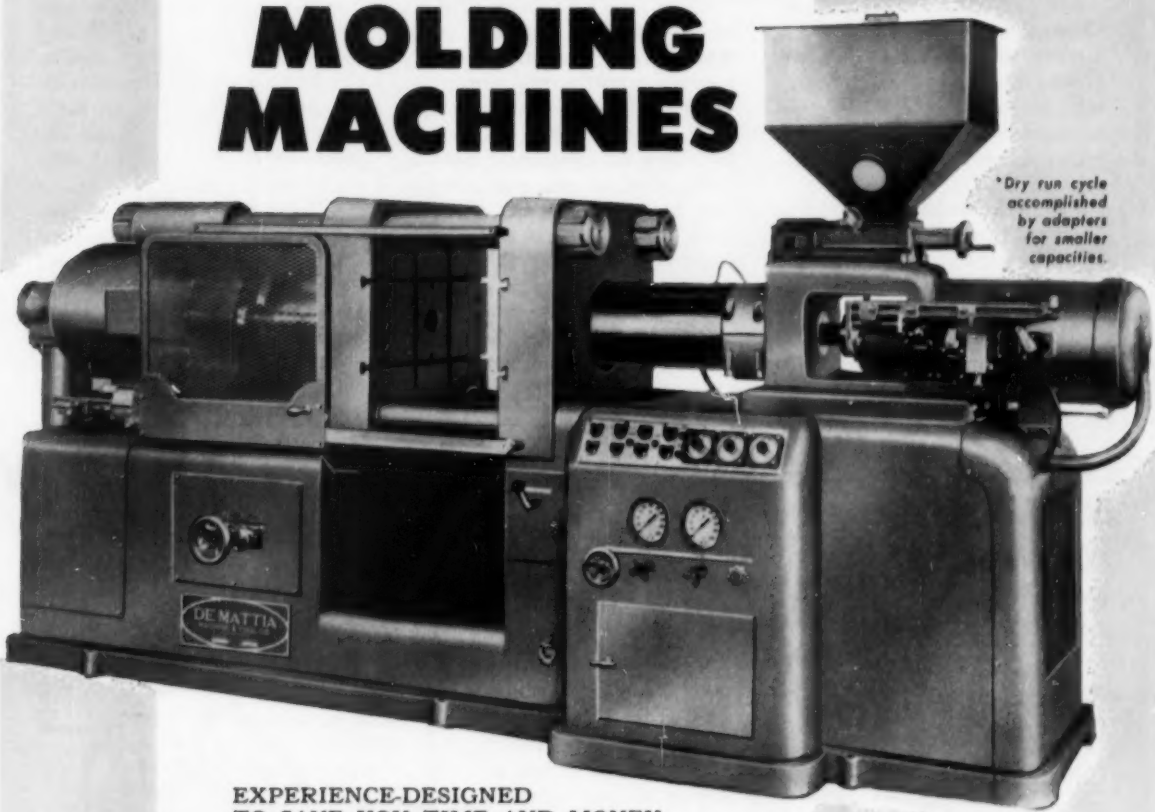
- UP TO 6 CYCLES PER MINUTE*
- 16 OUNCES BY AUTOMATIC PRE-PACKING



*Dry run cycle accomplished by adapters for smaller capacities.

EXPERIENCE-DESIGNED
TO SAVE YOU TIME AND MONEY

the new Model M Molding Machines are another step forward in molding production. These high efficiency injection machines help you meet competition... are expressly designed to increase your molding production and cut your molding costs. Series M machines offer fully hydraulic operation, up to 6 cycles per minute on smaller shots and shots up to 16 ounces by means of automatic pre-packing!

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cause they are man-made and therefore closely controlled during manufacture, can be more easily tailored to meet specific end-use requirements. As individual fibers, each offers a unique set of characteristics:

Polyester (Dacron, Du Pont): a tough, water repellent fiber that has good dimensional stability and good dielectric strength. Its flex life and shape retention are very good and it will resist heat (softens at about 450° F.), abrasion, and many chemicals.

Acrylic (Orlon, Du Pont; Acrilan, Chemstrand; Dynel, Carbide and Carbon Chemicals Co.): characterized by low moisture absorption, resistance to acids and most solvents, good dimensional stability, and good electrical characteristics.

Cellulose acetate (Arnel and Fortisan-36, Celanese): very high dielectric strength and resistance to fungus, mold, etc. Fortisan-36 has exceptional tensile strength and dimensional stability.

Nylon: very high tenacity in both dry and wet conditions; excellent resistance to abrasion and flexing; toughness; resistance to heat and many chemicals; and excellent electrical qualities. Nylon is already in use in the plastics laminating fields. Wellington Sears Co., Inc., for example, supplies a spun nylon fabric which provides laminates with superior insulation under high humidity conditions and a filament nylon fabric which provides outstanding impact resistance to low-pressure laminates, such as wing board linings for military aircraft.

Rayon has also been used to some extent in molding compounds and laminates. More recently, experimental quantities of Teflon fibers have been finding their way into industry. The Teflon fibers are completely inert to acids, alkalies, and most chemicals, have high tensile strength, good abrasion resistance, and resist heat up to 400° F.

Needled batts

Reinforced plastics laminates: Making a strong bid in this field are mechanically bonded reinforcing materials made up of Du Pont's Dacron polyester, Orlon acrylic, or nylon fibers. The material, in needled-batt structures, was developed by Troy Blanket Mills, and Charles Lachman Co., Inc., subsidiary of Mohawk Carpet Mills, Inc., in conjunction with Du Pont's Textile Fibers Depts., and is being produced commercially by both firms. The "blankets" are made by passing a carded batt through a needle loom which, in effect, stitches the fibers to themselves. This produces a strong, blanket-like fabric which is easy to handle and can be molded or tailored readily. The homogenous construction also permits fabrication of laminates of uniform thickness and unusually smooth surface. Ability of the batting to be deep drawn eliminates the necessity of preforming for many applications and contributes to laminate postformability. It is recommended for use where pressure molding is involved.

Although the three different fibers have much in common—

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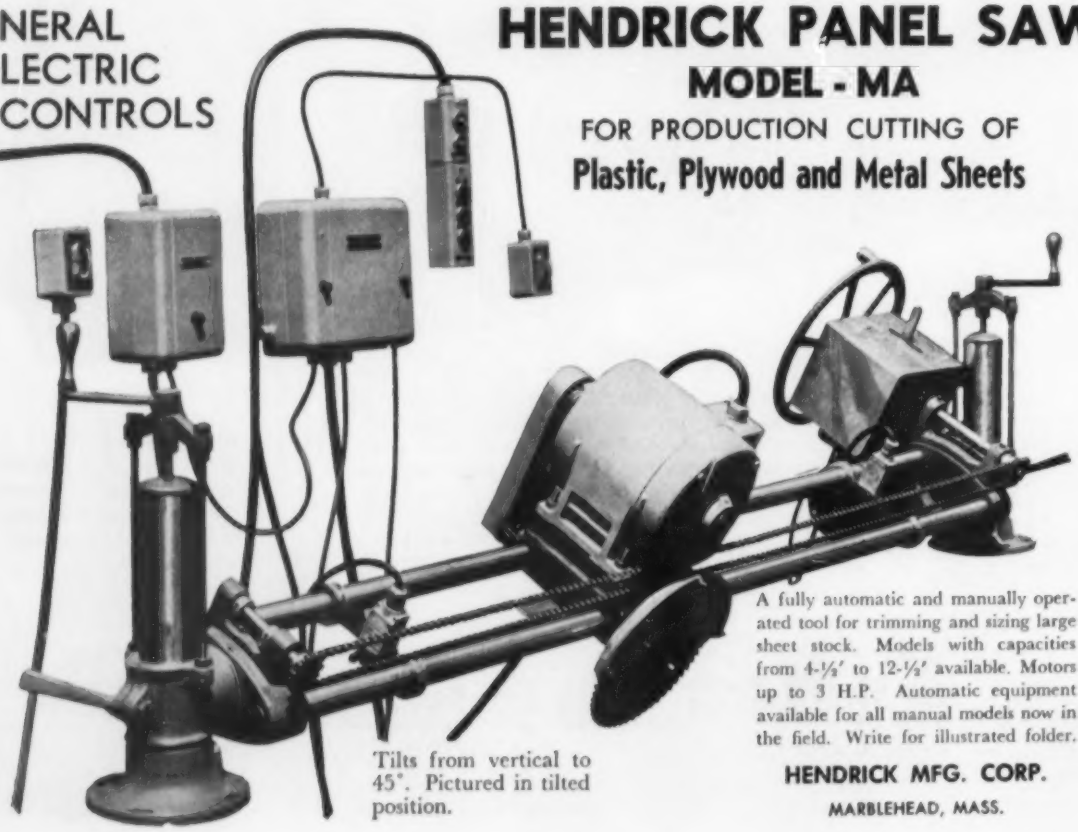

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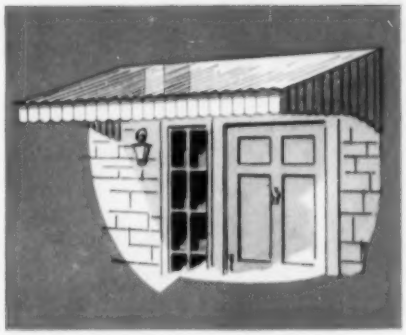

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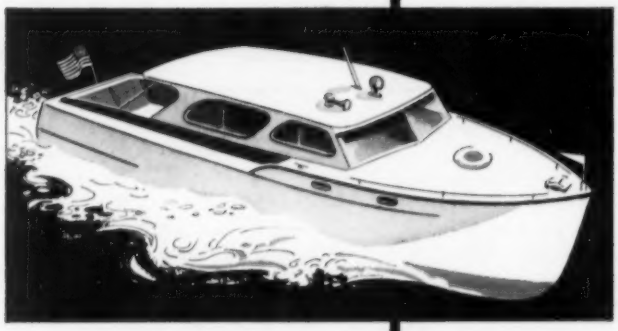

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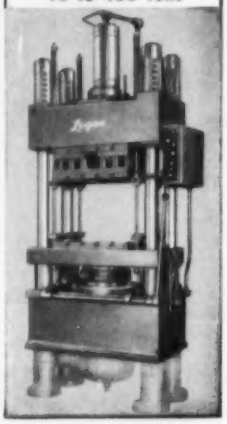

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low moisture absorption, excellent chemical resistance, high dielectric strength, abrasion and impact resistance, and weatherability — there is some variation in the magnitude of individual characteristics (see table, p. 83).

At the present time, the Dacron reinforcing batts seem to be receiving the most attention. A pallet for the meat industry has already been successfully introduced by Russell Reinforced Plastics Corp., and has aroused a good deal of interest in the possibilities of the Dacron batts for the food handling industries.

Other end-use areas for which the Dacron reinforcing batt is believed most suitable include: the electrical and electronics field; shower doors; schoolroom furniture (used as an overlay mat to provide abrasion resistance); boats (for surface appearance and abrasion resistance); radar domes (the material does not distort radar waves); and luggage.

For applications requiring high structural strength, Dacron can be used in conjunction with glass fibers as a surfacing or overlay mat.

The Orlon mat, with properties fairly close to those of Dacron, will probably wind up in the same areas of application. Orlon, however, shows exceptional promise for applications that require a smooth, automotive-type finish. After an Orlon-reinforced part is sanded, it can be wiped clean with a special solvent to create a smooth polished surface capable of accepting a high finish.

High-pressure laminates: Under commercial development is a method of calendering Dacron, Orlon, and nylon batts into thin sheets suitable for high-pressure laminating. The prime advantage of both materials for high-pressure laminates is their excellent electrical characteristics as indicated by the use currently being made of woven Orlon and nylon fabrics. One major laminator is seriously considering their use for printed circuit base laminates.

Molding compounds: Research is underway in the use of both Dacron and Orlon in the formulation of molding compounds; nylon is already being used to impart impact strength as well as chemical resistance to the finished product. An attempt is being made to develop a nylon-reinforced phenolic molding compound.

Most recently, the research department of Du Pont has come up with an Orlon batt reinforced acrylic resin exhibiting high-impact strength and good post forming characteristics. The Du Pont research department has already drawn the sheet to a depth of 6 in. on a conventional vacuum forming machine.

Tough new acetate fibers

Other synthetics making a strong bid for reinforced plastics and high-pressure laminating fields are acetate fibers being supplied by Celanese Corp. of America.

Reinforced plastics: An attractive combination of properties for reinforced plastics is inherent in Fortisan-36, an oriented and saponified acetate which has high tenacity, low stretch, unusual di-

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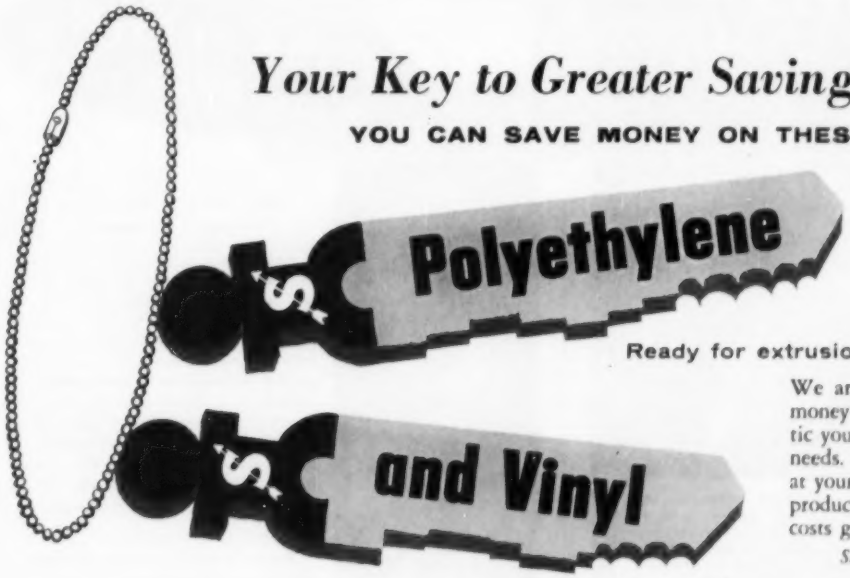

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mensional stability, and low specific gravity. According to Celanese, in panels of equal weight made of glass and Fortisan-36 fabrics, the latter laminate would be thicker and thus would have more edgewise compression stability. Such high stability per unit weight should be of interest to the aircraft field in the design of fuel cell support panels.

Cellulose acetate fibers have also been used in conjunction with glass-bleached kraft pulp mat for polyester laminates. The principal reason for using the paper pulp is to reduce the cost of the mat; by blending 10% of cellulose acetate fiber with the glass-kraft mat, the ability of the composite to absorb resin is improved. It is also reported that the glass kraft-acetate mats are less stiff and that, a more uniform product with an improved molded surface is obtained.

Cellulose acetate staple can be used alone or in an acetate-glass mixture as a mat on the surface of laminates for improved appearance and weathering.

High-pressure laminates: Phenolic laminates based on Fortisan-36 reinforcing fabric are under test in the high-pressure field. One commercial application that can already be reported is insulator links used in guy wires which support and hold in place tall radio antennas. The phenolic-Fortisan-36 laminate provides high strength insulators that display outstanding dimensional stability under sustained load.

Arnel, a cellulose triacetate fiber, is of particular interest in the high-pressure laminating field because of the high heat resistance and high electrical resistivity.

Synthetic papers for laminates

Two or three years back, the idea of manufacturing a paper product based on the synthetic fibers was considered an improbability. Today, a good number of them are already in pilot plant production. The manufacture of synthetic fiber paper is somewhat more difficult than that of conventional cellulose paper and each fiber necessitates a specific technique.

Because of the high cost of the 100% synthetic fiber papers, their use in the high-pressure laminating field will probably be in specialized markets where their excellent electrical characteristics, dimensional stability, and high-temperature resistance are prime factors.

Costs, of course, can be lowered by using the synthetics as reinforcements for cellulosic papers. Considerable development work has also been concentrated on handling resin-filled synthetic fibers in a one-step operation on the paper machine. This would help eliminate costs in treating paper prior to laminating and would make the new fiber papers more economically feasible.

New applications

Another type of application opening up for the synthetic fiber reinforcement is in casting compounds. Thus, Fasco Plastics reports the use of a specially formulated, tough nylon fiber in

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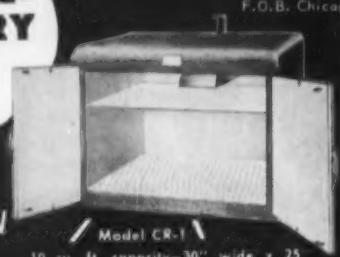

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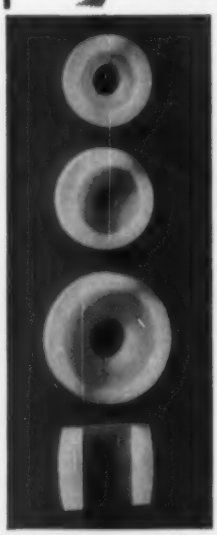

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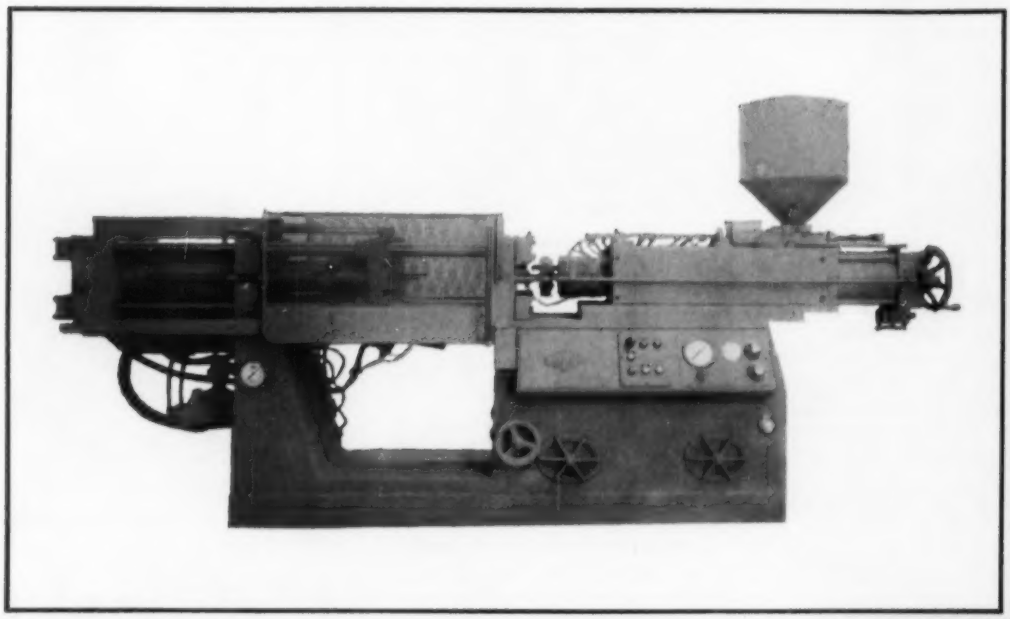

2-3 OUNCES

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polyester or epoxy casting. The nylon-reinforced compounds reportedly have double the strength of ordinary aluminum castings, are ⅔ the weight of aluminum, and will effectively resist shock and vibration. Just how versatile the synthetics can be is illustrated by some of the jobs currently being handled by Lunn Laminates, Inc., which reports that where chemical resistance is the desired requirement, Dynel fibers have been used. Non-woven Dynel is also put to work as overlay mats for improved surface appearance. Where shock and impact resistance are the important factors, very heavy nylon cloth, stretched and heat treated, has been used in Navy radomes as a surface skin over fibrous glass materials. When used as a core, the nylon has the best gunfire resistance of any material previously used.

Fibrous asbestos reinforcements

Asbestos materials have been in use in high-pressure laminates and in the formulation of certain molding compounds for at least 17 years. More recently, in several new forms (both by itself and in conjunction with glass fibers), asbestos is making a strong bid to expand existing markets in both of these fields and, at the same time, to extend its activities into the low-pressure laminate field.

In all three areas of application, asbestos fibers have much to offer, particularly in the way of heat and flame resistance, high strength at elevated temperatures, high modulus of elasticity, chemical and water resistance, thermal properties, improved dimensional stability, and good electrical properties. In common with other fibrous materials asbestos can be supplied in a variety of forms.

Raybestos-Manhattan, Inc., for example, one of the leading suppliers of asbestos materials, offers three basic forms: fabrics woven in the conventional manner; Pyrotex felts produced by mechanically opening mined asbestos fibers and processing them through carding machines; and Novabestos papers made from single, relatively long asbestos fibers produced by a chemical

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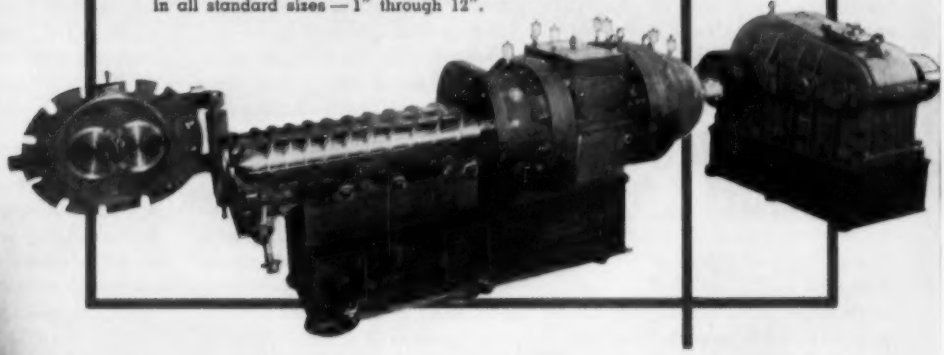

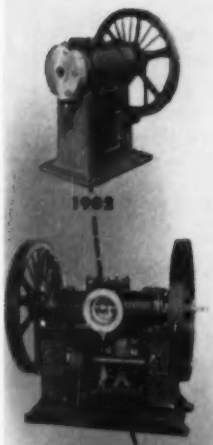

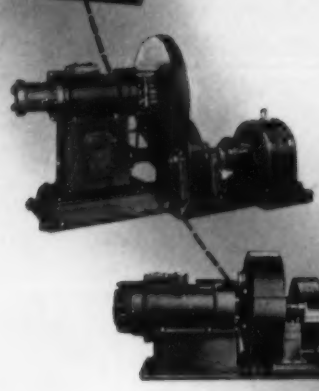

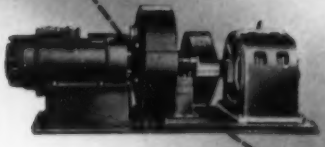

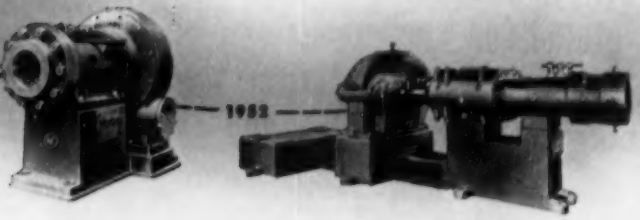

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method which separates the basic asbestos fiber into single component fibers and holds them apart in dispersed condition until the paper is made.

Asbestos felts are in wide use by high-pressure laminators, primarily in conjunction with phenolic resins for high heat resistance applications. More recently, they are finding their way into the low-pressure field.

The addition of Raybestos-Manhattan's Novabestos papers to the line of asbestos materials has opened still newer market areas. The papers have outstanding ability to stretch and distort, both dry and wet. In very thin laminates, the smoothness and uniform fiber distribution is particularly evident, providing greater uniformity of thickness and physical properties.

The papers may be used alone in laminates, or can be effectively combined with glass cloth or yarn as surfacing or interleaving materials. In such applications, the asbestos fibers tend to spread, surround the yarn, and thus cushion the glass, protecting it from abrasion caused by glass-to-glass contact.

Applications for asbestos

Potential laminate applications for asbestos felts, papers, and cloth include: paneling on air ducts in railroad cars, truck trailers, and aircraft; missile fins and vanes; containers for fuels, chemicals, or delicate instruments; electrical cables, insulators, and switch gears; rocket throats; fishing rods; corrugated panels; and decorative sheets. Asbestos felts and papers are especially applicable for thin laminates, 1/16 in. or less, where they retain their strength characteristics.

Experimental missile fins fabricated of asbestos felts impregnated with phenolic resin are reported as being tested by several aircraft companies. Such fins have been subjected to temperatures up to 3000° F. for periods of from a few seconds to several minutes with satisfactory results. Also in the area of high-speed aircraft applications are airfoil sections made up of polyester-impregnated asbestos felts as the skin of a sandwich construction with a foamed isocyanate core.

Experimental programs have also been initiated in evaluating asbestos-cushioned glass warp (a 4-mil layer of asbestos paper is laid over both sides of an evenly spaced warp of 150's glass threads) for rocket launcher bodies.

Still another application under consideration is the use of asbestos felts and papers for honeycomb cores that produce higher strength and stiffness properties at both lower and higher temperatures than standard cores.

Sisal fiber reinforcements

Sisal fiber is another reinforcing material that is not really new to the plastics industry. In recent months, however, its use has been extended to take in the realm of polyester resin premixes for compression molding.

The prime reason for using sisal is to lower cost. However,

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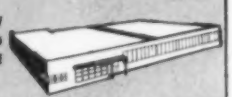

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since its strength is low, the economic advantage is justified only where a reduction in allowable stress is tolerable.

There are a number of applications currently on the market, however, which have made good use of the sisal fibers, notably the heater housing being molded for Chrysler by Woodall Industries, Inc., and Fabricon Products Div., Eagle-Pitcher Co.

How to evaluate

With all the reinforcing materials discussed above — including glass, the synthetics, asbestos, and sisal fibers — any evaluation of potential applications must be tempered by a study of the exact circumstances under which the end products will be used.

Reinforcements cannot be specified from a chart of physical properties alone. As this survey shows, there are many variables which have a bearing on general physical properties and which must be taken into consideration. This applies not only to the reinforcements themselves, but also to the resins and binders with which they will be used.

It is further to the advantage of the molder or laminator to familiarize himself more thoroughly with the know-how of the textile industry. Reinforced plastics are, after all, dependent on the products of the textile industry as well as the chemical industry — and when the services of both are better understood, the molder or laminator will be helped immeasurably in the task of selecting the right combination of reinforcement and resin to do the best job.

Acknowledgements

To the many companies who helped in the preparation of this article but who are not mentioned in the text, the editors of MODERN PLASTICS magazine wish to express their special thanks.

For a complete list of suppliers of glass, synthetic, and asbestos fibers, weavers and paper manufacturers, and laminators, fabricators, etc., making use of reinforcements, consult Directory section of MODERN PLASTICS Encyclopedia Issue, Sept. 1955.—END

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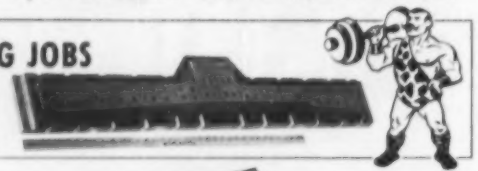

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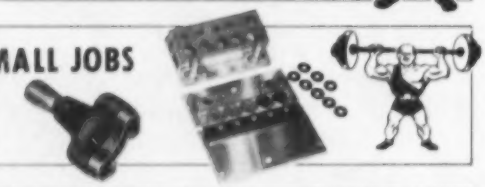

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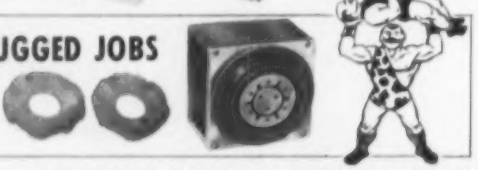

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Tripod

(*From page 87*)

the horizontal panning and panoram gear is molded of nylon. The inherent toughness of the material, its self-lubricating properties, and the fact that it provides excellent bearing action against the die-cast panning gear (a characteristic which helps overcome backlash) were the factors that decided the designer on this material. The drive worms are produced in a 12-cavity mold on a Minijector machine modified by the molder to handle nylon.

General-purpose styrene. The clutch inserts for the telescoping tripod legs are molded of this material. (Six inserts are used with each tripod, two for each leg.) These parts are thin-wall, cylindrical sleeves, chamfered externally at each end and split longitudinally. Their purpose is to provide a clamping action. When an outer knurled aluminum collar is tightened on an outer leg of the tripod, the styrene sleeve bears against an inner telescoping leg to provide a positive clamp.

The inserts are made in two diameters to correspond to the two lower sections of each three-section leg. They are injection molded in a 12-cavity mold on 6-oz. Lesters. The strength and durability of general purpose material, combined with its low price, were the reasons behind the selection of the material.

High-impact styrene. The control stem grip, the crank knob, the pawl release knob, and the camera pad are all injection molded of high-impact polystyrene. These four components are exposed and thus must combine pleasing appearance with a high degree of ruggedness. Tough, high-impact styrene, does just that.

Elastomeric vinyl. Three leg tips and an elevating post bumper cap are molded of vinyl. The material was preferred over rubber because of color-matching and finishing specifications, because it provides traction and resilience, and because of its low cost.

The high-impact styrene and elastomeric vinyl parts are all produced in a dual-purpose 10-cavity mold, incorporating a variable gate shut-off to handle the two materials. Molding is done on an 8-oz. Reed-Prentice.

The wise selection and incorporation of plastics components in the Superpod assembly contributes considerably to its functioning and eye appeal. Ever since its introduction to the market, the tripod has found enthusiastic consumer acceptance—proof again that sound use of plastics results in superior products.

Credits: Superpod was designed by Felix Gilbert and is produced by Testrite Instrument Co., New York, N. Y. All injection molded parts produced by Queen City Plastics, Inc., New Rochelle, N. Y. Zytel 101 nylon for drive worm by Du Pont; general-purpose and high-impact polystyrene by The Dow Chemical Co.; butyrate by Eastman Chemical Products, Inc.; elastomeric vinyl specially formulated by Queen City Plastics. Crystal lens for level formed by Testrite.

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DIAMOND CHEMICALS

Diamond Chemicals

Penthouse

(*From pp.* 92-94)

of the contours by pressure from clamping devices. Finish cuts were then scraped and sanded to remove burrs and rough edges.

Pre-assembly

Much of the actual assembly work was done away from the site of installation to facilitate the final erection of the structure. Each plastic sheet was fitted with a stainless steel "shoe" and "cap" during this pre-assembly. The cap is a complete channel and holds the plastic sheet rigidly in its jaws. The shoe is an L-shaped channel with a 100-degree angle to coincide with the angular cut in the plastic sheets.

A ⅛ in. thick strip of cork-neoprene was inserted between the end of the plastic panels and the channels to act as a seal and take up shock and vibration. The plastic was pushed into the cork-neoprene strip when the caps and shoes were pressure fitted in place. Twelve-foot clamps were used for this operation. Since the bottom "channel" is really only an angle, the pressure fit was obtained by means of stainless steel straps bolted to the plastic at each flat face of the corrugation. Several of these straps were left unattached for final adjustment at the time of installation.

Installing the sections

The framework for the penthouse consists of a steel and concrete skeleton, with a minimum of steel used to avoid distortion of the micro-wave signals. The plastic walls were installed on a brick-veneered, waist-high retaining wall from the top of which one leg of a steel angle protruded. A sheet of copper flashing was bent over the angle and the top of the wall.

First step in the final assembly consisted of bonding a P-shaped strip of neoprene rubber to the copper-covered channel on the wall. The bead was placed at the bottom and the heel of the shoe of the assembled sidewall rested on it. The bead provides for the expansion and contraction of the plastic sheet. The gasket itself insures a water-tight seal under the sidewall.

The prefabricated plastic wall was then installed. Once in position, the cap was bolted to a steel channel at the top of the framework. Then the shoe was secured. This was done by placing an L-shaped steel channel against the flat faces of the corrugations in the plastic sheets.

Six feet above the brick retaining wall is a steel supporting beam to which the plastic sheets were fastened by means of an unusual bolt assembly. As with all other assemblies in the structure, this too had to be watertight. Accordingly, the bolt was threaded through a steel washer, then a neoprene-rubber grommet. The smaller end of the grommet was inserted through a hole in the plastic. A cork-neoprene gasket was then placed over the protruding bolt and the assembly inserted through the steel beam. The neoprene grommet prevents leaks; the cork-neoprene gasket provides resiliency so that the plastic is not shattered or cracked when the bolt is tightened.

To assemble one plastic sheet to another, the "tongue" of one sheet was mated with the "groove" of another. Holes were drilled at 4-in. intervals through the mated parts and nylon fasteners or rivets inserted. These hold the sheets together tightly and also minimize leaks. Nylon was used because it will not distort the micro-wave signals.

The "tongue-and-groove" joint solved the problem of leakage resulting from the capillary action of wind-driven water. The "tongue-and-groove" were designed with a ⅛ in. clearance between the tip of the "tongue" and the bottom of the "groove." This space effectively breaks any capillary action which may start on the outside of the groove. Any water that may work its way in is trapped in the air space and runs out at the bottom.

Credits: Acrylic molding material supplied by Rohm & Haas Co., Philadelphia, Pa.; extrusion by Sheffield Plastics, Inc., Sheffield, Mass., using a Hartig 3½-in. extruder; assembly and installation by The Valley-National Corp., Milldale, Conn.

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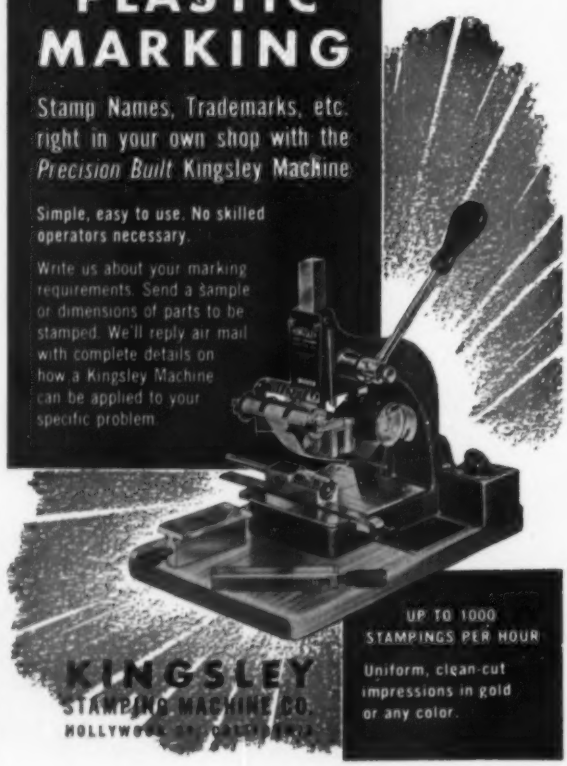

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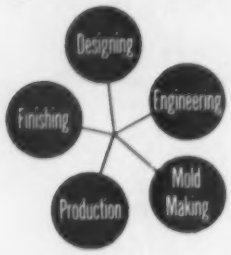

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'Flying disc'

(*From page 95*)

were shown at the Toy Fair in March. A number of resins were tried and finally it was necessary for General Electric's Chemical Materials Dept. to produce a special polyester formulation for the job. Three more molds were delivered to Camfield and all were in production by June 1. As Camfield molded the discs, they were shipped by chartered truck from the Zeeland plant to the Kalamazoo sled factory. Special handling trucks were made to allow for the same type of handling in the molding plant and the assembling plant. Loading 5000 discs into a semi-trailer truck is done in 20 min. and unloading in Kalamazoo takes the same length of time, thanks to the special trucks.

First assembly operation consists of punching holes for attaching the webbing hand straps and grommets for a pull rope. Shaped die blocks with inserted punches and button dies are used in a special press to accomplish this. The grommets are installed with a small foot power machine, and the handles are attached with a tubular rivet machine. The head of the rivet bears directly on the bottom of the disc proper and a special cup-type washer is used to grip the webbing strap to distribute the bearing load. After assembly, a large brightly colored display piece is placed in each disc and the discs are put into cartons of six, three each of bright orange and bright green. Thus far, production of the disc is continuing in equal quantities of orange and green—an apparently satisfactory choice.

Kalamazoo Sled Co. is so pleased with the sales results of this development that it plans to develop other products which will incorporate the same reinforced plastic moldings so that the molds can be kept in production the year-round. A water disc has been considered, but tests have shown that the design was not right for that use. It is quite possible that the kids themselves will come through with good ideas on the subject.—END

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VACUUM FORMING MACHINE. Illustrated brochure describes two models of the "Vacform" vacuum forming machine, lists specifications, and describes in detail how the equipment is used. Vacuum Forming Corporation. (B-602)

SECONDARY PLASTICIZER FOR VINYL RESINS. Technical bulletin gives typical physical properties, formulation and quality advantages of "Conoco H-340," a secondary plasticizer for vinyl resins. Prices included. Continental Oil Company (B-603)

AUTOMATIC HYDRAULIC PRESSES. Detailed specifications sheet describes three molding presses for thermosetting materials. Information given includes platen area, stroke, closure speed, etc. Baker Brothers, Inc. (B-604)

HOT LEAF MARKING PRESS. Illustrated literature gives features, specifications of "Kensol 351" air-operated, electrically dwell-timed hot leaf stamping and embossing press; suitable for marking plastic items up to 3¾ inches high. Olsenmark Corp. (B-605)

FAR-INFRARED HEATERS. Illustrated brochure describes in detail the features and advantages of "Chromalox" electric radiant heaters, shows many actual installations, lists specifications and prices. Edwin L. Wiegand Company. (B-606)

COUNTERBORING TOOL. Illustrated literature describes and gives specifications and prices for leader pin and bushing counterboring tool for mold makers; available in nominal size pin and bushing diameters of ⅝ to 1⅜ inches. Detroit Mold Engineering Co. (B-607)

WAX ADDITIVE FOR PLASTICS. Descriptive literature gives details on "Polymekon," a petroleum wax derivative; describes uses as mold release and lubricant in extrusion work, and as a heat and light stabilizer for PVC resins. Warwick Wax Company, Inc. (B-608)

COMPRESSION MOLDING PRESS. Illustrated literature describes 50- and 25-ton models of the "Automold" fully automatic molding press for fast-curing thermosetting material. Automatic Molding Machine Company. (B-609)

STABILIZERS FOR VINYL RESINS. 24-page booklet describes line of 14 "Stayrite" stabilizers for vinyl resins, and gives suggestions and general recommendations for use of stabilizers. Witco Chemical Company. (B-610)

STEEL FOR MOLDS. Literature gives technical data on "Crusca 12B" chromium nickel steel for machine-cut molds used in high pressure molding operations. Crucible Steel Company of America. (B-611)

TIPS ON FINISHING REINFORCED PLASTICS. Illustrated reprint discusses how to machine and polish glass fiber–reinforced plastic products by using abrasive wheels, belts, and pads on electrically-driven tools. The Carborundum Company. (B-612)

CATALOG FOR INJECTION MOLDERS. 65-page illustrated catalog gives complete specifications and prices for line of grinders, heating cylinders, nozzles, drum tumblers, and other injection molding accessory equipment. Injection Molders Supply Company. (B-613)

CORROSION RESISTANT PIPE. Catalog illustrated with schematic drawings gives detailed specifications for line of "Agile" corrosion-proof thermoplastic pipe, fittings, valves, tubing and ducting, and gives the properties of the five plastic materials from which the piping is produced. American Agile Corporation. (B-614)

ENAMEL SPRAY COATING FOR PHENOLICS. Literature describes "Rexclad" enamel spray coating for phenolic products, available in a range of finishes from low to high gloss and in many colors, including metallic; also gives sample of sprayed phenolic material. Rexton Finishes, Inc. (B-615)

HYDRAULIC HOBBING PRESSES. Illustrated brochure gives specifications for line of completely self-contained hydraulic hobbing presses with capacities from 100 to 2000 tons. M & N Hydraulic Press Company. (B-616)

DATA FILE ON EPOXY RESINS. File of technical literature gives information on applications, characteristics, prices and methods of using "Marblette" heat-setting and cold-setting epoxy resins for laminating, casting and coating applications. The Marblette Corporation. (B-617)

METALLIZED MATERIALS. Swatch-book describes and gives samples of available patterns, colors, and constructions of "Doray," a metallized polyester film bonded to various backings. Dorrie Process Co. (B-618)

VACUUM FORMED PLASTIC PACKAGES. Illustrated brochure explains vacuum system of forming thermoplastic sheet, describes this company's facilities for providing such service, and illustrates several vacuum formed packages and displays. Nordic Plastics Company, Inc. (B-619)

ROTARY FINISHERS. Brochure provides pictures, specifications, and details of operation of line of machines designed for high speed grinding, polishing, buffing, trimming, grooving of circular and turned plastic parts. J. M. Nash Co. (B-620)

PYROMETER CONTROLLER. Specification sheet on a pyrometer controller of the potentiometer signaling type which is available in a selection of standard scales ranging from 0-600° F. to 0-3000° F. Thermo Electric Co. Inc. (B-621)

COLOR COMPARATOR. Details on equipment developed for scientific reproduction of "natural daylight" or "true North Light" to permit accurate color matching twenty-four hours a day in any weather. Gives construction and operating features of the unit which makes possible human-eye detection of color variations. Crown Engineering and Sales Company. (B-622)

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DIE STEEL. Illustrated technical literature gives detailed appraisal of physical and chemical characteristics of "Cascade" steel for plastic molds and dies; gives suggestions for machining, finishing, and hardening, and gives list of stock shapes and sizes available. Latrobe Steel Company. **(B-625)**

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RIGID PLASTCS SHEETING. Illustrated literature lists physical, chemical and electrical properties of "Vinylite" rigid thermoplastic sheeting, available transparent or opaque in standard or custom sizes. Transilwrap Company. **(B-628)**

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SANDING, POLISHING AND GRINDING MACHINES. Illustrated catalog describes extensive line of abrasive grinders, sanders, and polishers; includes models for a wide variety of finishing operations. Curtis Machine Corporation. **(B-632)**

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CATALOG OF CHEMICAL PRODUCTS. 35-page catalog of chemical products produced by this company contains information on applications and on physical and chemical properties; includes many chemicals used by plastics industry. Eastman Chemical Products Inc. **(B-642)**

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VACUUM FORMING. General information on the process of vacuum forming thermo-plastic sheet materials in the manufacture of displays, toys, industrial components, and similar items. Special emphasis is given to the use of "Mirro-Brite" metallized butyrate. Coating Products. **(B-644)**

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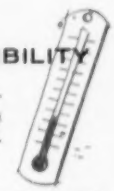

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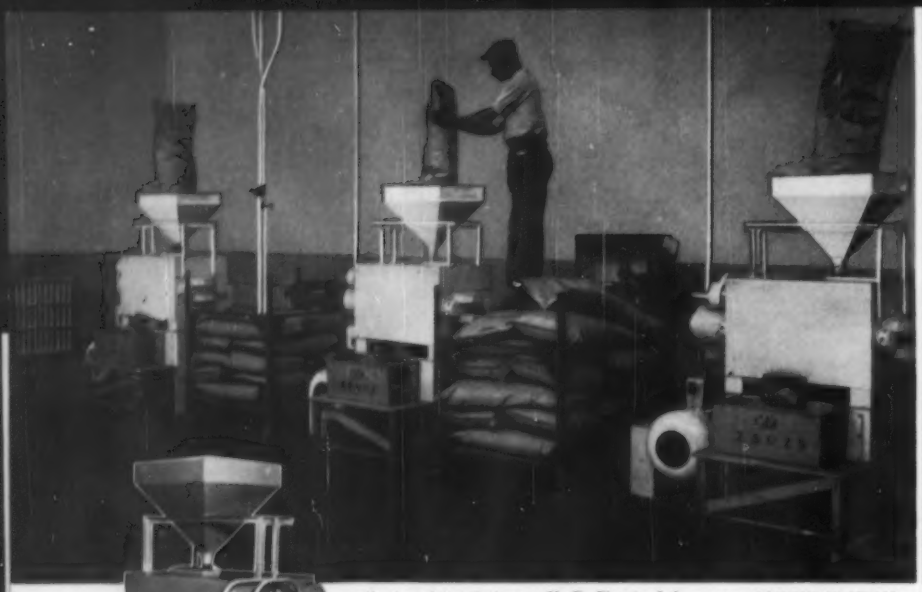

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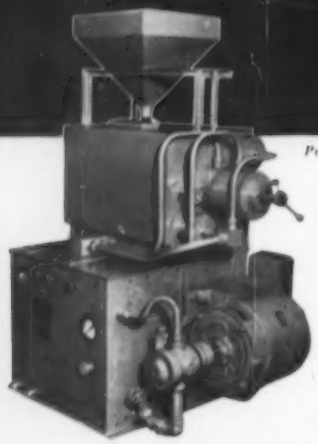

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maximum pressure	12 tons	35 tons	70 tons
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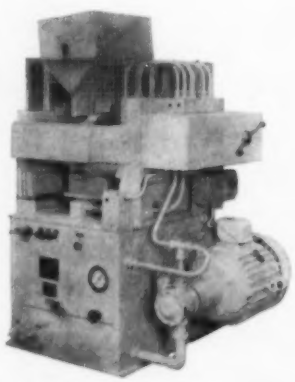

BIPEL PRESSES

Perfect companion to the Bipel Pelleter . . . the semi-automatic BIPEL "Auto-Control" Compression Transfer Presses can reproduce any conceivable molding cycle at the touch of a button! Adds several extra cycles per hour. Variable range of pressures: 20 to 340 tons. Write for complete details.

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(From pp. 96-99)

cycle. They are molded simultaneously in separate single-cavity dies mounted in a 2000-ton compression press.

The length of the tapering tail section (52 in.) is such that a special arrangement is made to permit insertion of the preform in the cavity and removal of the molded part from the punch. This is accomplished by mounting the tail section cavity on four heavy-duty rollers which fit a pair of tracks beneath the male half of the mold. The cavity is moved back and forth on the track by a hydraulic cylinder arrangement. With the cavity withdrawn from beneath the upraised punch, the operator has no difficulty in placing the tail section preforms in the mold or removing the molded parts from the male mold at the end of the cycle. A measured quantity of flexible polyester resin is poured into both of the preforms before closing the press. These components are also edge-trimmed and tested for air leaks immediately after molding.

Sections cemented together

Final assembly of the plastic fuel tanks involves cementing the three center sections together, mounting the nose and tail moldings in position, and installing the various non-plastic components of the tanks, such as the fuel outlet assembly, the forward and aft hanger brackets, filler cap, and other parts. Prior to assembly, all areas of the molded laminates which are to be cemented together are shot-blasted in an enclosed booth to insure maximum strength in the cemented joints. The nose, tail, and center section pieces are also placed on fixtures where a number of holes are drilled along the lap joint and bulkhead areas for the cadmium plated self-tapping screws which speed the assembly process and reinforce the adhesive bonds.

The circular bulkhead pieces are placed in a multiple spindle press which pierces a number of openings through which two of the pieces are bolted back-to-back to form each bulkhead. At the same time that these holes are pierced, a larger opening is punched through each bulkhead molding, near the flanged edge, so that fuel will not be trapped in the bottom of the tank by the bulkheads when the supply is running low. Another operation performed prior to final tank assembly consists of cutting out the round openings for the fore and aft fuel filler caps.

Conveyor assembly line

During the assembly process, the molded plastic sections are placed on jigs and fixtures which are moved along on a roller conveyor line to successive stations where further operations are performed. Fixtures are constructed so that they may be rotated from side to side, making both the inner and outer tank surfaces accessible for assembly.

One of the first steps in the assembly process is mounting the fore and aft bulkheads on the

inner surface of the top center section. Spaced equidistant from the center of gravity of the tank, the bulkheads contribute added structural strength at the point where the two hanger brackets and "U" bolts which mount the tank to the bomb racks of the aircraft are located. The bulkheads are cemented in place and steel plates which bear on the flanges of each bulkhead provide additional anchorage for the hanger bracket bolts.

The fuel outlet assembly, static electricity assembly, filler cap assembly, and several other components are mounted in the top center section skin. Then epoxy resin adhesive is applied to the prepared lap joints and the two other center sections are joined to the top component. The cadmium plated self-tapping screws are driven into the drilled holes, using a power screw driver. Each screw has a rubber grommet which insures an air-tight seal.

After completion of the center section, the nose and tail components of the tank are similarly cemented and fastened in place. Due to the relatively short pot life of the adhesive, the epoxy resin and activator are combined in small batches and passed to the assemblers in paper containers. Spatulas are used to apply the prepared adhesive.

After assembly has been completed, the tanks, transferred to wheeled carriers, are rolled into a large oven where they are subjected to a temperature of approximately 150° F. for several hours to speed up the cure of the epoxy adhesive. Upon removal from the oven, tanks are placed in adjacent test cages and connected to air lines for an internal pressure test. During this test, which is run at a maximum pressure of 15 p.s.i., tanks are connected to a manometer which reveals any drop in pressure through seam failure.

Upon the completion of this test, pressure is reduced to 6 p.s.i. and the tanks are removed from the cages. Next a soap solution is applied to the entire surface of each tank and the tank is closely inspected for any small leaks which would not show up during the manometer test. Tanks are then washed off, dried, and decals are applied which state the capacity, their identification, and the location of the filler cap.

One additional test which is run from time to time on completed tanks is a "slosh and vibration" test. This operation is designed to simulate conditions encountered in actual flight.

Credits: Glass fiber mat or rovings supplied by Ferro Chemical Corp., Bedford, Ohio; Libbey-Owens-Ford Glass Fibers Co., Toledo, Ohio; Owens-Corning Fiberglas Corp., New York, N. Y.; Pittsburgh Plate Glass Co., Fiber Glass Div., Pittsburgh, Pa. Polyester resins, Bakelite Co., Div. of Union Carbide and Carbon Corp., New York, N. Y.; The Glidden Co., Cleveland, Ohio; Pittsburgh Plate Glass Co., Selectron Resins Div., Pittsburgh, Pa.; Rohm & Haas Co., Resinous Products Div., Philadelphia, Pa. Epoxy-type adhesive (Epon VI), Shell Chemical Corp., New York, N. Y.

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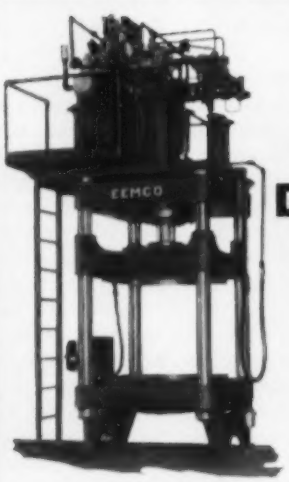

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Resists edge fraying, has great tear strength... is ideal for tough jobs.

Resists effects of corrosion and moisture over wide range of temperature and humidity.

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Polyliner

(From pp. 109-114)

cular flutes; k and n are flow constants which differ for each plastic; $k = 1.6 \times 10^{-12}$ for Lucite 140 acrylic resin; 1.7×10^{-16} for Zytel 101 nylon resin; $n = 2$ for Lucite 140; 2.4 for Zytel 101.

For non-isothermal conditions, the basic flow relationships involving pressure drop, flow rates, non-Newtonian characteristics of the melt, influence of the geometry of the channels, variations in wall temperatures, and shear stresses were solved successfully on the IBM 701 computer.

In practice it has been found simpler to design a general-purpose liner which will be suitable for a wide range of molding conditions. One design of polyliner can cover the whole range of plastic materials which are commonly used in the field. Only the cylinder dimensions need be known to design such a liner.

The fit between liner and cylinder should be as close as possible for maximum heat transfer. It is recommended that the liner be made of a metal having a greater coefficient of thermal expansion than the steel of the cylinder. By so doing, an extremely tight fit between liner and cylinder is obtained when the metals expand as they reach molding temperature. Among the metals used are No. 304 stainless steel, Ampco 18-22, and beryllium copper.

Polyliners for a great variety of machines of many manufacturers have already been built. The machines have varied in size from 1 oz. up to 16 ounces.

Conclusion

The Sales Service Laboratory of the Polychemicals Dept. of Du Pont will be glad to make their data and information on the design and operation of polyliners available. Simple design formulas for polyliners have been worked out.

Acknowledgments

The theoretical studies reported in this paper were contributed by R. E. Gee and O. M. Hahn, whose help the authors wish to acknowledge.—END

"A plasticizer for every purpose"

insurance for SECONDARY PLASTICIZER USERS

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If you use a secondary plasticizer you should select a primary to use with it that is capable of "holding" as large a percentage of the secondary as is possible.

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KP-220 offers you added protection against bleeding at your present primary to secondary ratio. It also allows you to substantially decrease this ratio without bleeding thus reducing the cost of your formulation. In certain formulations the use of KP-220 has allowed the ratio of primary to secondary to be decreased substantially.

In a specific formulation, using a chlorinated paraffin as a secondary, laboratory tests proved KP-220 to be the only primary tested among several commercial types that did not bleed when used in an amount equal to that of the paraffin. A sample containing 23.5 parts of KP-220 and 23.5 parts of a chlorinated paraffin secondary with PVC was tested for a period of 29 months and proved completely compatible after that time.

If you need added protection against secondary plasticizer bleeding and are interested in reducing the pound volume cost of your present formulation, you should evaluate KP-220.

Technical data and samples of KP-220 are available and will be sent immediately upon request.

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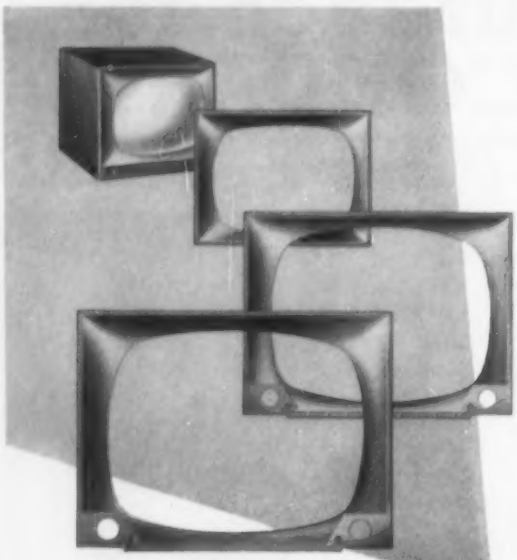

NELCO

Lacquers

frame the best pictures

The lacquer finish on the polystyrene "mask" or frame (shown above) surrounding the picture tube is vital to good TV viewing. Glare and reflection must be reduced to a minimum and colors must blend attractively with the television cabinet.

Here is how NELCO Lacquers serve one major television manufacturer:

The Problem
To lacquer finish black polystyrene "masks", attractively, economically.

The Answer
Production-line, hand-spraying with one coat of flat, fast drying NELCO Polystyrene Lacquer.

The Results
Handsome, no-glare, non-reflective finish.
Scratch and blush resistant.
Excellent adhesion.
Reduction of costs. No-glare lacquer replaces expensive etching of metal molds.

NELCO lacquer formulations are available in all metallic shades for every coating requirement — cellulose acetate, vinyl, acrylic, cellulose acetate butyrate and rubber. Write for complete information on these lacquers and, for our recommendations, just outline your problem to us.

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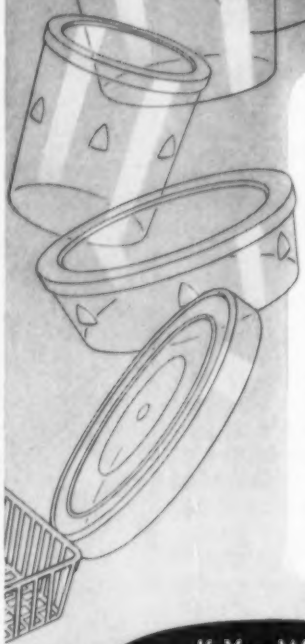

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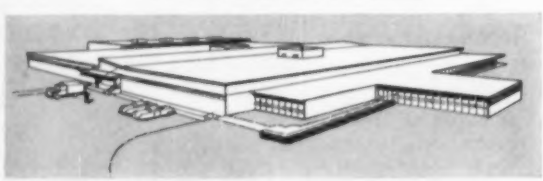

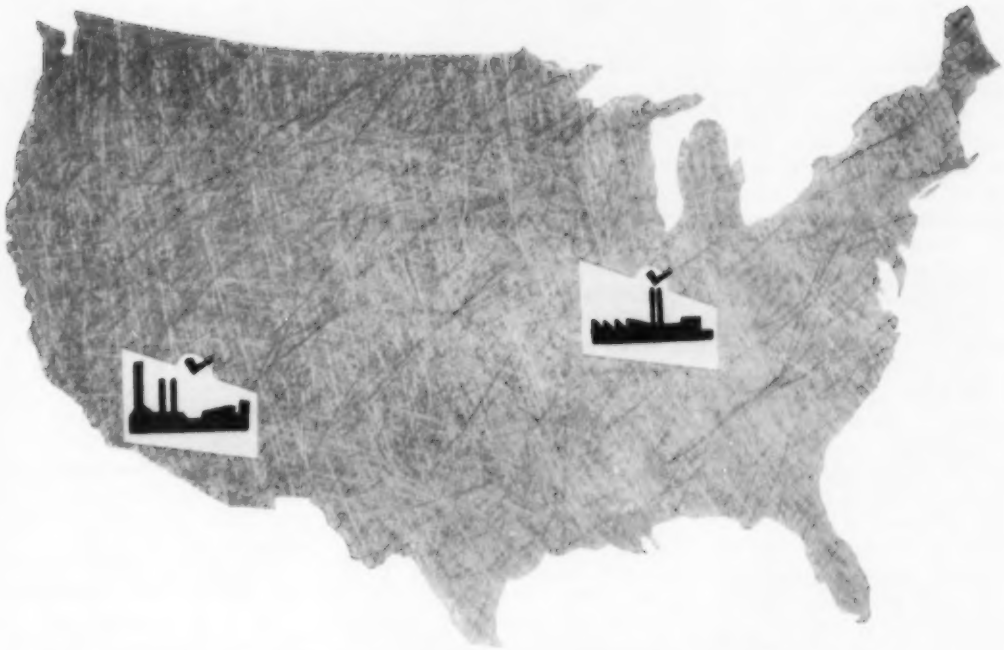

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Electrostatic

(*From pp. 127-136*)

this conductive, and yet not harm the physical properties of the material. A similar effect could be produced, as stated in reference 1, by making the volume of the plastic in the immediate vicinity of the surface conducting; most of the charge resides near the surface. There is a limit to the degree of conduction, however, that should be imparted to the surface regions if plastic is to remain transparent.

7. If the polymer to be used is intended for an application requiring good electrical insulation properties, the static charge must be accepted as a necessary evil. It may be possible to reduce it by placing non-metals between the plastic and the metal mold during molding. In one instance brought to the authors' attention, a blush below the surface was occurring erratically in a pigmented molded material, being improved for a time by changing mold plates and later recurring during use of the new plates, but disappearing when the original plates were put back. Provision of a nonmetallic film between the plastic material and the metal mold removed the difficulty. However, experimentation would be necessary to find a suitable material of this sort.

8. The qualitative correlation between the charge transfer during sliding and metal-plastic adhesion seems to be worth investigating further.

We should like to acknowledge the benefit of critical discussions with Prof. Earle C. Gregg in respect to our interpretation of the 200 or so color pictures of which Fig. 5 is a sample.

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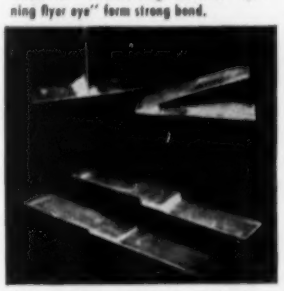

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Phenolic resin

(*From pp.* 139-152)

and a 189% range in dehydration pressure, with other operating conditions varying proportionately as shown in Table VII, p. 152. The test of this technique to predict and to correlate was, therefore, believed moderately severe.

Yet, despite the range of these variables, the stroke cure of 3 out of 5 batches fell within 10 sec. of the predicted value. Of the two runs deviating significantly from the laboratory data, one (run 10-38) could have been brought measurably closer to the expected line if the laboratory initial reaction time of 30 min. had been used instead of the 22.5 min. actually employed. The causes responsible for the deviation of the other run, however, (10-24) are not known.

It therefore appears probable that, using the above techniques and reaction rate data from the laboratory, stroke cure on the type of resins here processed can be predicted within ± 10 sec for any reasonable process scale-up. This is adequate accuracy for most work.

If these correlations are used for the evaluation of new processes, it is expected that the accuracy will decrease as the process changes being considered become more and more major relative to the process on which the data were obtained. This would be expected from the nature of the assumptions which have been discussed earlier and is in line with results which are described above.

The above results are fairly typical. It is felt that they justify the general conclusion that stroke cure, and hence other product properties (measured at constant water content) can be related to the processing conditions through the use of reaction rate data and equivalent reaction time. The effect of process cycle variations, whether resulting from scale-up factors or from imposed operating conditions, can thus be predicted from laboratory data. Mathematically, this technique is equivalent to reducing all cycles to a standard isothermal cycle with time as the only variable. Its practical usefulness in development work as well as in factory process engineering techniques is obvious.

The above techniques relate stroke cure to process variables and thus answer half the problem. The second half of the problem, that of relating resin water content to process variables, is discussed below.

Water content versus process variables

The break in the viscosity chart (Fig. 3) represents one technique for determining maximum water solubility in the resin, with water contents immediately in excess thereof leading to a free water phase emulsified in the resin, as discussed earlier.

For most commercial operations, a resin of low water content is desired and is readily

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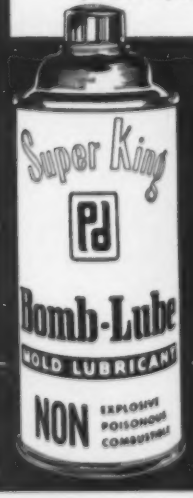

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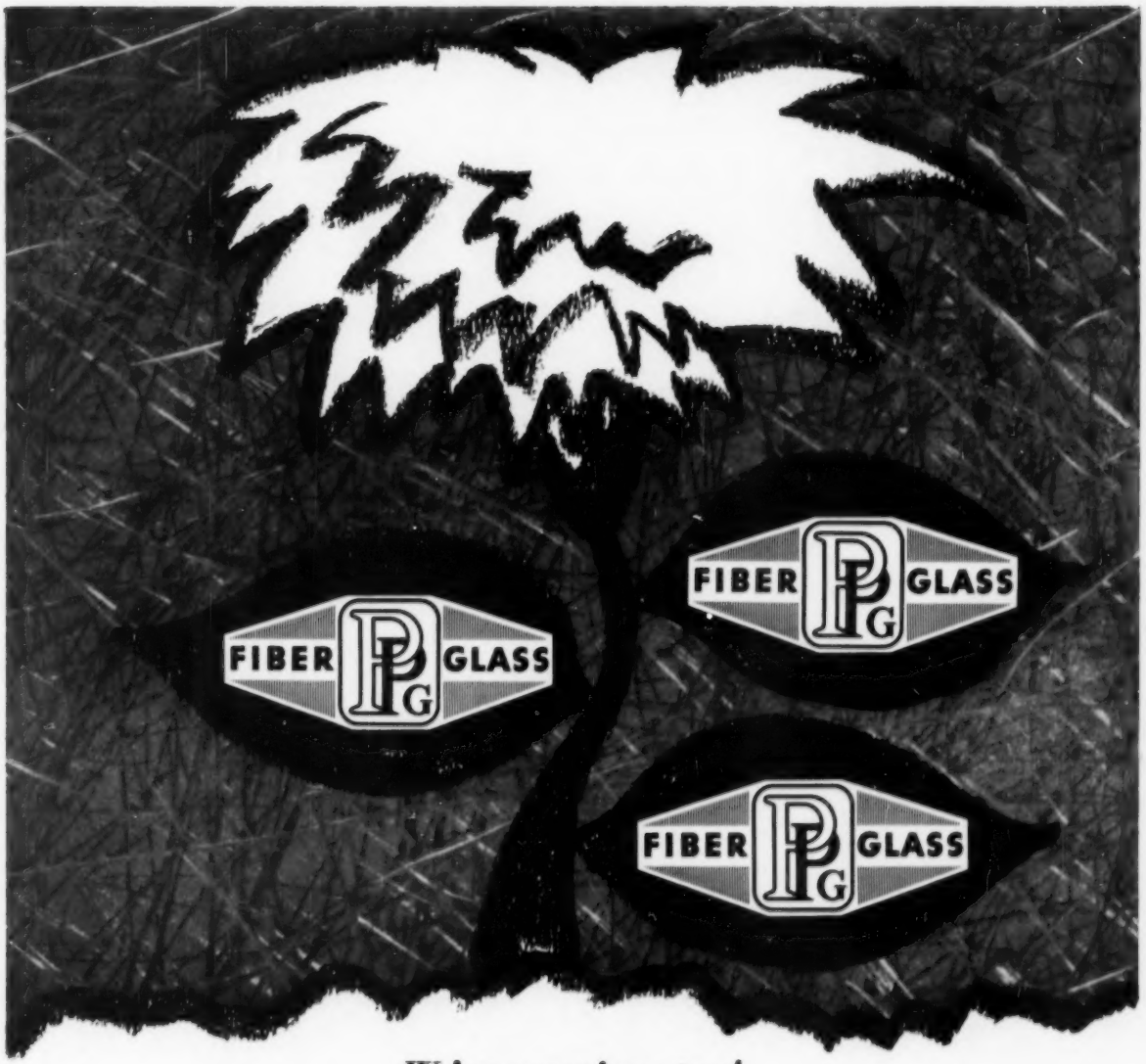

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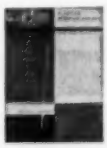

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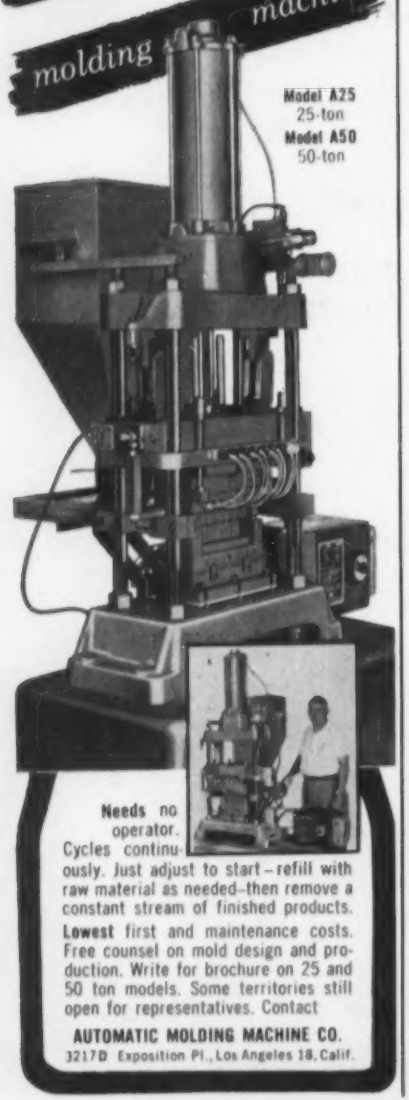

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obtained by employing elevated dump temperatures and low pressures. Nevertheless, primarily to indicate that a classical approach would be successful here too, a limited study of water content versus temperature and pressure was made.

First, the boiling point at 740 mm. pressure (Pittsfield, Mass.) of a modified Formulation *B* versus water content was determined. The procedure was to place a small quantity of resin from a batch of known water content on a plate at fixed and uniform temperature and check for boiling. This technique permitted bringing the resin to the desired temperature in such a short time that advancement did not occur. By successive experiments, each employing fresh resin, boiling point could be readily established within 5° C. and probably within 3° C. (Fig. 8). Using Fig. 8 and the vapor pressure-temperature relations of water, a Duhring chart was prepared (Fig. 9). The predicted water content from the dump temperature and pressure was then compared with the actual measured value in a series of laboratory runs with the results shown in Table VIII, above. The agreement is obviously quite satisfactory.

Table VIII: Effect of dump temperature on water content of phenolic resins

Run No.	*Final or Dump Temp.* °C.	*Pressure* mm. Hg	*Resin Water Content Predicted* %	*Measured* %
5-124	43.5	65	9.5	10.5
5-130	44	64	9.0	8.96
5-132	49	55	4.0	4.14
5-134	45	63	8.0	7.42

Difficulties in maintaining close control over the vacuum in the pilot plant equipment prevented test of this knowledge on larger scale. However, the principles are sound, and there seems no reason to doubt this approach.

Conclusions

It was the initial objective of this study not to obtain correlations applicable to a few specific formulations, but to indicate a possible general approach to the study and design of phenolic resol resin manufacturing processes. To this end, it has been shown that stroke cure and water content are all important in establishing the resin properties normally specified (flow point, melt, grindability, and caking time). The first is believed to owe its importance to being related to degree of condensation, while the last seems to function as a plasticizer.

It has then further been shown that stroke cure can be predicted with considerable accuracy by combining the proposed process cycle conditions with reaction rate data from the literature and laboratory data despite wide changes in scale of operation or process cycle. Evidence has also been presented to indicate that water content of the phenolic resin can be predicted from a Duhring chart.

Hence, a nominal amount of laboratory data can be employed with classical physical-chemical principles to 1) predict the effect of widely different process changes, 2) analyze factory records, 3) avoid troubles, and 4) choose optimum conditions.

Acknowledgments

The authors wish to acknowledge the valuable assistance of Messrs. J. McDevitt, F. Scheib, H. Schwartzman, and E. W. Turner, who collaborated in obtaining and evaluating much of the data reported herein, and they further wish to express their appreciation to General Electric Co.'s Chemical Div. management for permission to publish this paper.—END

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The Plastiscope

News and interpretations of the news

By R. L. Van Boskirk

(*Continued from pp. 37-40*)

Vinyl film conference

Don't try to be a big shot—just be your own very best self if you want to be a good salesman! That was the parting and crowning advice hurled at the members of the S.P.I. Film, Sheeting, and Coated Fabrics Conference, recently held in New York City. Bill Gove, vice president, E. M. C. Recordings, Inc., Minneapolis, Minn., was the gentleman who mirthfully, but forcefully, impressed his audience with the desirability of the modest but purposeful approach to selling.

His talk followed directly after and added emphasis to the pronouncement by the old master merchandiser J. C. Penney (who is himself a big plastics customer) that the key to selling is service. Everyone gave ostensible approval to that thesis, but there is considerable doubt that there was unanimous approval for Mr. Penney's other major thesis that "the more the merrier" is the happiest way to find prosperity. Film fabricators and converters have been growling for years about an overcrowded industry. They would be hard to convince that another competitor's plant next door to each of those now in existence would increase the profits of those already in business.

Still another master retail craftsman, Mr. Ephraim Freedman of Macy's, gave a rather startling about-face twist to the usual oratory given forth from the consumer angle at vinyl film meetings. Members have by now become quite accustomed to being told that their products need upgrading, better labels, less of this, and more of that. They would expect to get scolded at these meetings even if their goods were acceptable to the angels—it's become a habit. But Mr. Freedman turned on the other faucet. He literally oozed with compliments and highest quality praise for the quality of goods now coming out of the vinyl film and sheeting factories. And Mr. Freedman is the dean of all retail testers who pass on vinyl quality—praise from him is indeed praise from the ivory tower. But he left a significant word of caution—"Keep it up!"

New products discussed in papers read at the Film Conference were vinyl foam, laminates of vinyl to rigid materials, and structural applications for film or sheeting.

There are now 25 licensees in the U. S. and nine in Canada or Europe for the mechanically blown Elastomer vinyl foam. Progress in the last six months has been exceptionally good. According to Reuben Wisotzky of L. E. Carpenter & Co., the significance of its future possibilities is that it gives the designer a third dimension—that of thickness—to work with in handling vinyl products. Vinyl foam used as a filler between two pieces of vinyl film is not only a filler but provides structure and resilience. It not only gives more strength than conventional fillers, but can be used over simple curves or compound-curved surfaces and improves the decorative possibilities of vinyl surfaces.

Mr. Wisotzky called particular attention to the necessity for discrimination in submitting vinyl foam to the same tests used for rubber foam. The relationship between density and load-bearing characteristic, which is so important in understanding the properties of foam rubber, do not necessarily apply in the case of vinyl foam. The load-carrying properties of foam rubber improve with increasing density. The load carrying properties of foam vinyl are related to the amount and type of plasticizer as to the product density. Foam vinyl of 6-lb./cu. ft. density can be formulated to carry as much load as foam vinyl of 9-lb./cu. ft. density. On the other hand, foam rubber of 6-lb./cu. ft. density normally supports only half the load that foam rubber of 9-lb./cu. ft. density would support.

Various other comparisons of test methods for the two materials were made by the speaker. Any person interested in these comparisons plus other warnings in the handling of vinyl foam would do well to obtain a copy of Mr. Wisotzky's talk from S.P.I., 64 West 44th St., New York 36, N. Y.

Other comparatively new uses discussed at the conference were vinyl vapor barriers in construction, rigid vinyl ceiling installations, flexible vinyl lighting panels, and vinyl-surfaced hardwood panels for parquet flooring. Vinyl-to-metal laminates also received thorough and competent treatment in one of the conference's better papers. This latter topic was the subject of a comprehensive article in the June 1955 issue of MODERN PLASTICS.

The greater portion of the conference papers were devoted to techniques of processing and handling vinyl film and sheeting. Among them were the use of water inks for valley printing; the development of large-size, automatic heat sealers that are capable of turning out as much production in one month as the older machines could turn out in a year, but with the accompanying problem of trying to educate purchasers on how to use them; the development of roll-binding units to minimize the problems of roll crown on vinyl calenders; determination of best coating methods to fit the job at hand; methods for automatic weighing and others.

Most of these papers may be obtained from the Society of the Plastics Industry at the address noted above.

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The Plastiscope

and 444 Madison Ave., New York, N. Y., has been placed with private investors, according to Hans Wyman, president of Pantasote.

Mr. Wyman states that the debentures will be convertible into Pantasote common stock and that the money will be used to finance part of the construction of the new polyvinyl chloride plant for Eleonora, which is being built in Passaic, N. J.

The new plant will produce raw material used by the parent company for the manufacture of coated fabrics for the transportation industry and vinyl film and sheeting for draperies and upholstery.

Nylon distributor

Users of nylon rods, sheets, tubes, and strips may now obtain quantity shipments of nylon stocks from Cadillac Plastic & Chemical Co.'s warehouses in Detroit, Chicago, St. Louis, Los Angeles, and San Francisco, according to an announcement from the company.

Cadillac states that no change in nylon prices is anticipated at the present time.

Plastics in England

Among the plastics applications at the Building Exhibition recently held in London, England, was an exhibit of new fittings for jointing polyethylene tubing by Yorkshire Copper Works, Ltd. These are injection molded in high-molecular-weight, low-pressure polyethylene and have a good melting point (128 to 135° C.) and tensile strength. Their advantage for coupling is their rigidity, an important feature on those applications where screw threads are used.

Included in other polyethylene plumbing exhibits were examples of molded cisterns for big and low-level systems, as well as samples of polyethylene syphons and floats.

An unusual use of vinyl plastisols was seen in cast articles ranging from delicate statuettes to ornamental masonry over 2 sq. ft., with a corresponding depth, produced in molds made from hot melt compounds. The flexibility of the molds allows the use of undercuts without consequent problems of extraction.

One firm displayed a flooring material consisting basically of a vinyl composition like plaster in consistency, which can be spread by trowel on existing floors. The flooring can be laid in thicknesses up to 1/16 in., and drying time is up to 24 hours. Among wall tiles shown was one which was self-adhesive.

Other applications of plastics on display were self-adhesive strips of polyurethane foam for draft sealing purposes; formed acrylic sink units; honeycomb structures for use in door construction; and tissue-faced fine glass fibers with P.V.C. vapor-sealed edges for insulation purposes.

Epoxies everywhere

During the past several months, this magazine has received an ever-increasing number of reports concerning developments in the use and production of epoxy materials. Because of the great interest in this comparatively new and growing segment of plastics, these various reports have been assembled here to present a consolidated picture of the various activities that are taking place in this branch of the industry.

Low-viscosity Epon. Latest addition to Shell Chemical Corp.'s widely used series of Epon resins is Epon 815, a low-viscosity structural resin. This new 100% reactive resin is said to be especially useful in laminates prepared by the vacuum-bag and contact-pressure techniques. Its low viscosity (500 to 900 cp.) allows Epon 815 to penetrate rapidly even the most closely woven glass fabrics. The resulting laminates have high glass content and hence great strength. Contact-pressure laminates can easily be prepared with Epon 815 having glass contents as high as 60 percent. Using the vacuum-bag technique, glass content in the range of 70% is possible.

In castings and in adhesive applications, the resin also gives good performance. Casting materials based on Epon 815 can incorporate more filler, permitting better control of exothermic heat and shrinkage. Because of their higher filler content, adhesives can be formulated with Epon 815 which will have coefficients of expansion that match closely those of certain metals.

Shell also announces that experimental quantities of Epon Curing Agent T, for use with Epon resins, is now available. Development of this new curing agent resulted from continuing efforts to eliminate the handling problems associated with the early aliphatic polyamine hardeners.

A low-viscosity, high-boiling liquid, Agent T is expected to find its principal use in room-temperature contact-pressure laminating, especially in the tooling field and in automobile body patch kits. In such applications, its low viscosity results in better wetting of the glass cloth and thus somewhat stronger laminates than can be obtained with previously available room-temperature curing agents.

Laminating resin. Good thixotropic properties, particularly in its ability to cling to walls and ceilings without dripping, is the claim made for Epocast 2 C, an epoxy paste laminating resin produced by Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif.

In application, a hardener is mixed with the paste laminating resin. This is brushed on surfaces to be protected and then glass cloth is pressed into place roughly by hand, followed by squeegee or roller pressure. In this manner, it is possible to apply the resin to a wide variety of surfaces. Although a paste, Epocast 2 C rapidly penetrates and thoroughly wets the glass fabric.

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THE PLASTISCOPE

Dry Colorants and Concentrates

AN EXTENSIVE expansion program centering around the manufacture of concentrated pigment dispersions and a complete line of specially prepared dry colorants for thermoplastic molding compounds has been announced by American Molding Powder & Chemical Co., Div. of A. Bamberger Corp., 703 Bedford Ave., Brooklyn 6, N. Y.

The newly developed concentrates will be marketed under the tradename Master Color; the dry colorants under Kromaplast.

Master Color will be used primarily with polyethylene and vinyl. The first concentrated dispersion to be offered will be a jet black which conforms to the most rigid dispersion requirements of Bell Telephone Laboratory specifications. It is suitable for such applications as submarine cable, pipe, etc., where the destructive effects of aging are present. Additional Master Color dispersions are being developed.

Kromaplast dry colorants for general-purpose and high-impact polystyrene and polytheylene has a color range that will include all standards to approximate P.S.P. requirements, and special effects.

Because of its recent affiliation with Ansbacher-Siegle Corp., a pigment producer, American now has at its disposal Ansbacher-Siegle's technical knowledge and experience developed over years of color research. The firm is now basic in the dry colorant field from the actual pigment development and manufacture to the packaging and marketing of the finished dispersions.

With the manufacture of Master Color and Kromaplast, American is now in the position to custom compound polyethylene and vinyl using its own Master Color concentrated pigment dispersions. The company will specialize as sub-contractors to polyethylene and vinyl producers in color compounding.

The entire development and production of Master Color and Kromaplast is under the supervision of Edward J. Sheridan, Jr., former chief chemist of R-B-H Div., Interchemical Corp., and subsequently general manager of Sun Chemical Corp.'s Pigments Div. Until his recent appointment as vice president of American, Mr. Sheridan was associated with Ansbacher-Siegle.

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CHICAGO OFFICE AND WAREHOUSE
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The Plastiscope

sistant surfaces on industrial structures; in laminating fibrous glass jigs and fixtures; and in surfacing wood, metal, and concrete storage tanks.

Casting formulations. Single-component epoxy casting formulations requiring no catalysts or hardeners are available from Aries Laboratories, Inc., 270 Park Ave., New York 17, N. Y.

Designated Aritemp, the resins are free-flowing powders which, on melting, form low-viscosity solutions permitting the impregnation and sealing of complex electronic components.

A unique property claimed for these resins is that they become rubbery rather than brittle at high temperatures, thus making it possible to use them with fragile components containing fine wires which are prone to damage. Potted components may be temperature cycled from —60 to 150° C. without the development of cracks or dielectric losses.

Sheet for epoxy dies. Development of a high-melting-point wax sheet, to be used in making epoxy resin dies, has been announced by Harsyd Chemicals, Inc., Holland, Mich. The material, called Harcopol, is available in sizes 11 by 16 in. and in thicknesses from 30 to 130 mils. The nominal softening point is around 280 to 300° F. As a means of establishing a control, the melting point is determined by cutting a triangular piece from the sheet ⅛ in. on a side, pressing it on the bulb of a thermometer so the specimen projects out from the bulb at a 45° angle to the horizontal, and rotating the thermometer. The temperature at which the specimen slides around the bulb to the bottom is taken as the melting point.

The company states that the material's ability to remain tough at high reaction temperatures is probably its most important property. Because the risk of the sheet failing at the reaction temperatures of the epoxy is eliminated, there is good insurance against the loss of the die. Since the reaction temperatures fluctuate with the mass of the resin in the die, the use of the Harcopol sheet makes this a much less critical condition to be controlled, from die to die.

Adhesive for metal or plastics. Metal-to-metal or metal-to-rigid plastics bonding can be effected by a one-component thixotropic epoxy adhesive produced by Rubber & Asbestos Corp., Bloomfield, N. J., under the tradename "Bondmaster M620."

By eliminating the mixing of a separate resin and hardener, this formulation permits use of adhesive bonding in the mass production. Since the adhesive may be used directly from the shipping container, the need for specialized personnel formerly required for accurate measuring, weighing, and mixing of two-component adhesives has been eliminated.

Bondmaster M620 offers a wide choice of practical curing cycles ranging from approximately 7 min. at 535° F. down to approximately 1½ hr. at 350° F. Lower curing temperatures, down to 260° F., may also be used where a longer curing time cycle can be tolerated in production.

The thixotropic nature of the material results in a complete absence of drip or "run" either before or during cure.

General-purpose epoxy. Low thermal coefficient of expansion and stability over a temperature range of —100 to 400° F. is claimed for Stycast 2651, an epoxy-type casting resin produced by Emerson & Cuming, Inc., 869 Washington St., Canton, Mass. It is suggested as a material that will give good adhesion to metals, plastics, and ceramics.

The material is easy to pour as received, and can be thinned still further by heating to 100° F. or by adding the company's special cement. It requires only slight stirring before addition of the catalyst. Color is normally black, but it can be color-coded to specification.

Generally, room-temperature curing requires 8 hours. Elevated-temperature cure requires 1 hr. at 210 to 220° F. for castings below 200 g. or about 2 hr. at 160 to 170° F. Variations in curing time also depend upon the type of catalyst used.

In grinding wheels. Epon resin-based adhesives are being used by The Sterling Grinding Wheel Co., Tiffin, Ohio. The application is for bonding vitrified wheel to an aluminum insert, exactly on center and without warpage. A resinoid cement formulation had previously been used. The epoxy adhesive is supplied by Armstrong Products Co., Warsaw, Ind.

Epoxy coating for tubes. Tubing with an epoxy coating is offered by Tube-Kote, Inc., P. O. Box 20037, Houston 25, Texas. The company custom coats both the interior and exterior of any size or shape of pipe or tubing, storage tanks, valves, couplings, etc.

Tests indicate that the company's TK-31 epoxy coating is especially effective as a durable, abrasion-resistant coating for pipe line and oil well drill pipe.

West coast distributor. Additional warehouse space for handling Araldite epoxy resins has been acquired by Delmonte Plastics Corp., Los Angeles, Calif., west coast representatives of the plastics division of Ciba Co., Inc. Various types of the material are avaible from Delmonte in 500-lb. drum and carload quantities.

A full line. Breadth of product line that is possible when working with epoxy resins is demonstrated by the variety of formulations placed on the market by Carl H. Biggs Co., 11616 West Pico Blvd., W. Los Angeles, Calif. Marketed under the name of Helix Products, these formulations include adhesives, potting compounds, protective coatings, and a metal mender or filler.

Two of the newest are one- and

(*To page* 260)

Comparison proves

the Fellows "6-200" leads the field!

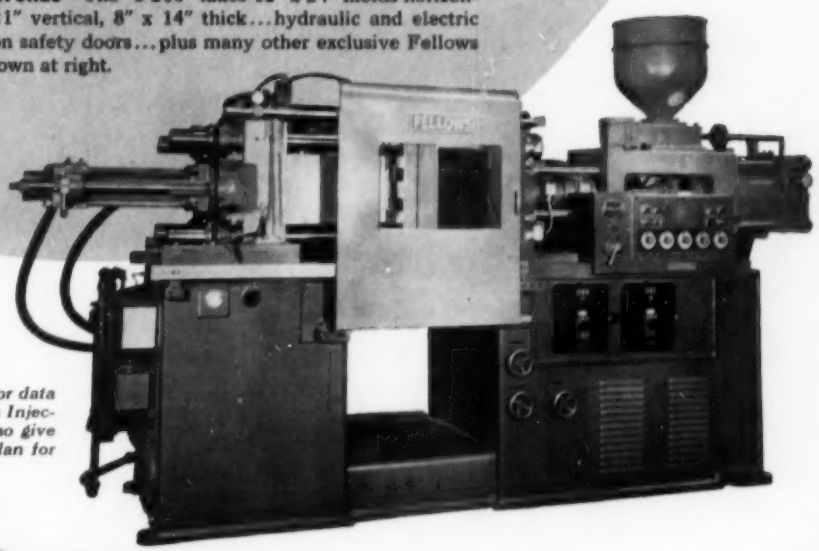
☑ **CAPACITY**—The "6-200" is the fastest fully automatic FULL 6 OUNCE machine on the market! "Pre-Pack and Pre-Positioned" device (optional) brings plunger halfway forward during press dwell . . . providing up to 8 OUNCE "SHOTS."

☑ **SPEED**—Thanks to such features as variable stroke adjustment, rapid advance injection, and new, improved Speed-Flo heating cylinder . . . the "6-200" delivers "dry-run" speeds from 490 to 650 cycles per hour.

☑ **FULLY AUTOMATIC**—Only the "6-200" gives you all the automatic features which allow one man to operate three or more machines! Grouped built-in temperature, injection pressure and speed controls! Counter, air-blast connections, alarm timer and safety device for mold . . . as extra equipment!

☑ **EASY SET-UP**—Entire press hydraulically retracts from nozzle for purging . . . plenty of open space on all sides of die platen . . . mold opens 6 to 9 inches . . . single control clamping adjustment.

☑ **BONUS FEATURES**—The "6-200" takes 12" x 24" molds horizontal, 15" x 21" vertical, 8" x 14" thick . . . hydraulic and electric interlocks on safety doors . . . plus many other exclusive Fellows features, shown at right.



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Fellows

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balanced line

New.....

Monsanto supplies a completely balanced line of general-purpose styrene crystal

Lustrex Hi-Flow 55

a soft flow general-purpose styrene for *uniformly* thin wall applications like containers, and *uniformly* heavy sections such as brush backs.

Lustrex* Hi-Flow 66

a medium flow general-purpose styrene for thin-and-thick wall applications.

Lustrex Hi-Flow 77

a standard flow general-purpose styrene for quick set up. (Formerly called Lustrex L)

. . . . . complements already famous Hi-Flow 55 and Hi-Flow 77

With the availability of Lustrex Hi-Flow 66, Monsanto now offers the industry the most *complete* range in general-purpose styrene crystal compounds ever produced.

In performance characteristics Monsanto's newest polymer falls between the now famous Lustrex Hi-Flow 55 and Lustrex Hi-Flow 77—giving you a line of widest versatility to meet any general-purpose molding application from softest flow to quickest setting.

All Lustrex formulations are ready for immediate shipment in pelleted crystal. (Lustrex Hi-Flow 55 and Hi-Flow 77 are also furnished in a broad range of colors and in colorant blend for dry coloring. For colors and colorant blend in new Lustrex Hi-Flow 66, consult your Monsanto representative.)

In addition to general-purpose styrene materials, Monsanto also supplies Lustrex LHA (improved toughness, medium impact); Lustrex Hi-Test 88 (rubber modified high-impact); Lustrex Hi-Heat 99 (with heat resistance up to 204° F.) and Lustrex LXC (a super high heat resistant copolymer designed for high heat applications).

Write today for data sheets. Address Monsanto Chemical Company, Plastics Division, Room 661, Springfield 2, Mass.

MONSANTO

*Lustrex Reg. U. S. Pat. Off.

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two-component epoxy-type metal adhesives. The two-component material, known as Bonding Agent R-390, is supplied in a tacky paste form and is cured at room temperature with a catalyst. After cure, it will stand temperatures up to 400° F. No holding fixtures are needed during cure. It is used to bond ceramics, plastics, rubber, and glass to metal, as well as metal to metal.

The one-component adhesive is Bonding Agent R-385. It is supplied ready to use and is cured by baking 1 hr. at 325° F. No preassembly drying or precure is needed. After curing, the adhesive will withstand temperatures up to 500° F. It is used to bond various materials to metal as well as metal to metal.

Oldest of the Helix adhesives is Bonding Agent R-313, a two-component thermosetting epoxy which will cure at room temperature in a few hours or can be cured faster by baking. Biggs Co. claims it is still the best for average applications. It is specially suggested to bond and hermetically seal instruments, electrical circuits, and components. It will hermetically seal windows into instrument cases; save drilling, tapping, and riveting; and solve many problems of bonding glass, plastics, neoprene, leather, cork, mica, and quartz to metal. It is also used to bond and seal fluid and pressure lines into connections, housings, and castings.

Bonding Agent R-318 is an epoxy adhesive similar to 313, but slightly more flexible. It is used principally for bonding rubber to metal or other materials.

The company's epoxy potting compound P-420 is furnished in liquid form, is poured cold and will cure in about 2 hr. at room temperature. Used as an embedment material, it hermetically seals a circuit; prevents unskilled workers from meddling with intricate wiring, but permits them to remove and replace complete embedded units; eliminates mounting hardware; and permits bare point-to-point wiring. It maintains, even after complete cure, enough flexibility to prevent cracking in hot-cold cycling.

Flawmaster is the company's pulverized metal-filled epoxy which is used to fill blowholes in machined and raw castings to eliminate sand pits, small gas holes, cracks, nicks, and scratches, as well as machining flaws and porous areas in precision metal parts. It is furnished in aluminum, brass, bronze, zinc, iron, and magnesium. The viscosity can be controlled from a thin liquid to a heavy putty-like paste.

Biggs also merchandises three epoxy surface coating resins that have unusual adhesion to metal even without a primer coat. They provide properties comparable to baked finishes without the necessity of baking. One is for spray coating; another gives maximum thickness for brush or roller coating; the third is primarily for dip coating.

Stripper-solvent. Valuable parts can now be salvaged from defective units potted in cured epoxy or polyester resins with the use of Monastrip EP, a stripper-solvent developed by Mona Industries, Inc., Patterson 4, N. J.

The product is claimed to be non-corrosive and non-flammable. It is easily applied by soaking the unit in any closed, pressure-tight container which will prevent evaporation of the volatiles from the reusable solvent. The solvent-stripper is also suitable for localized access to defects without stripping the entire unit, and is claimed to be an excellent mold cleaner.

Monastrip EP is sold with a money-back guarantee in 1-, 5-, 12-, 30-, and 55-gal. containers.

Laminating resin. Epoxy laminating resin 607 and surface coat resin 604 have been especially formulated by Marblette Corp., Long Island City, N. Y., for reduction or elimination of toxic effects. Resin 607 has a long storage life without refrigeration. It provides excellent laminating bond strength, has low viscosity, and thoroughly wets fibrous glass to produce a bond which assertedly will not delaminate. Reinforced plastic tools made from the cured laminate have been tested to demonstrate good chemical resistance, low shrinkage, and dimensional stability.

Resin 604 is a heavy-consistency epoxy type liquid that will spread evenly and will not run off on vertical surfaces. It is used as a gel coat on molds and models, particularly when it is undesirable to have the texture of the glass fibers show through the surface of the laminate.

Hardener for epoxies. Introduction of a new chemical, Het Anhydride, has been announced by Hooker Electrochemical Co., Niagara Falls, N. Y. One of the major uses for the product is expected to be as a hardener or curing agent for liquid epoxy resins.

The company states that Het Anhydride offers fire resistance and high-temperature strength—two properties heretofore unavailable together among the commonly used hardeners. A.S.T.M. heat distortion values approach 200° C. (392° F.). In addition, the combined raw material cost of Het Anhydride and epoxies is usually lower than other combinations. Also, no dermatological effects have been observed. It has good electrical characteristics and retains them at high operating temperatures. The product is sold in drums at 55¢ a lb., F.O.B. Niagara Falls, N. Y.

Epoxy for splicing. An improved version of its Scotch-cast insulation resin in the Unipak field-use container has been announced by Minnesota Mining & Mfg. Co., St. Paul 9, Minn. In addition, three sizes of the package are now available—an important economy feature since the resin has to be used immediately after the formulation has been mixed.

The company states that the epoxy-type resin in the special self-mixing package makes it possible to produce factory-per-

CRUCIBLE CSM 2 mold in press at Pro-phy-lac-tic Brush Co., Florence, Mass. The mold, built by Eagle Tool & Machine Co., Hillside, New Jersey, produces vegetable pans for Hotpoint refrigerators.

why **CRUCIBLE CSM 2**

is chosen for so many big molds . . .

One reason is that CRUCIBLE CSM 2 is always uniform in structure and composition. It's got to be. For the quality of every *heat* is controlled by Quantometer analysis . . . and every *piece*, regardless of size, is ultrasonically inspected. This means superior machining and polishing characteristics.

Another reason is that CRUCIBLE CSM 2 is immediately available from *warehouse* stock in 205 sizes, big and small. The job isn't held up for steel when you order CSM 2, the mold steel you can *trust* and get *when* you want it. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

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fect splices in power and communication cable under field conditions. The splice is embedded in liquid resin which hardens in a few minutes without application of heat and forms a permanent, moisture-resistant jacket of durable insulation material.

The improved Unipak container consists of a single package with a barrier strip sealed across the middle, separating the resin and activator. By pulling on the sides of the container, the barrier strip breaks and allows the resin and activator to mix. The previous Unipak container consisted of two separate packages, placed one inside the other.

White epoxy. Now available from Rezolin, Inc., 5736 W. 96th St., Los Angeles 45, Calif., are two white epoxies—L-904, a laminating resin, and L-914, a gel coat.

L-904, a modified epoxy resin said to possess good dimensional stability, is brilliant white in color and demonstrates good liquid life properties. It is suggested for use in tooling; it is easy to handle and apply in standard laminating techniques.

L-914 is a white gel coat material that provides good hanging properties and will harden with an exceptionally high gloss on a laminated surface at ambient temperatures. The product is claimed to be well suited for achieving continuity of surface properties. L-914 is a modified epoxy resin with good dimensional stability.

Epoxy tubing for coil forms. Small diameter, thin-walled epoxy tubing developed for use with coil forms is now available from Resdel Corp., Wildwood, N. J. The tubing will be manufactured to customer specifications and will be made of the same resin used in Resdel's molding or encapsulating operation.

The diameter can be from 0.350 in. up and wall thicknesses from 0.010 in. and heavier. Standard length is 26 inches. The round tubing may be readily formed to the triangular and rectangular shapes required for some uses.

Coated fabric price increase

A price increase averaging 3% on all vinyl Naugahyde upholstery materials has been announced by United States Rubber Co., Rockefeller Center, New York 20, N. Y. The increase ranges from 2 to 12¢ a linear yd. on vinyl-coated fabrics.

George Callum, sales manager of coated fabrics, states that the price change reflects the wage increase at U. S. Rubber, as well as rising cost of fabrics and raw materials. It is the first increase in elastic Naugahyde prices since the vinyl upholstery with stretchy backing was introduced by the company in 1950.

Synvar phenolics

Two new molding compounds—Synvar PM-6599 (black) and Synvar PM-6499 (brown)—have been added to the present line of phenolic molding compounds by Synvar Corp., Wilmington, Del.

Both compounds are of the general-purpose type and are characterized by an extremely fast curing speed and good flow, making them suitable for both compression and transfer applications. They are available in a full range of flows.

Vinyl acetate wood glue

Latest addition to the line of Roltite products manufactured by Midcontinent Adhesive Co., Grove City, Ohio, is Roltite White Glue, a fast-setting polyvinyl acetate adhesive. Obtaining an initial set in 20 to 30 min. the product reaches maximum strength in 24 to 72 hours. Glued joints can be worked as soon as the initial set is obtained.

Other advantages over older types of glues are claimed to include immunity to attack by mold and bacteria, high moisture resistance, and drying to an invisible glue line which is a non-abrasive film that will not dull cutting tools.

Before it is dry, excess Roltite White Glue can be wiped from glued objects with a damp cloth and rinsed from brushes and other tools with warm water.

Among the materials which can be bonded easily and permanently with the new Roltite glue are wood, leather, cloth, paper, composition board, plastics, plywood, Masonite, and linoleum.

Further details on the new product, including a complete specifications sheet, may be obtained from the company.

Safety data

Publication of a new, revised safety data sheet on hydrogen peroxide has been announced by Manufacturing Chemists' Association, Inc., 1625 Eye St., N.W., Washington 6, D. C. The 20-page booklet gives properties and essential information for the safe handling and use of hydrogen peroxide, including details on shipping containers, storage, waste disposal, and health hazards and their control.

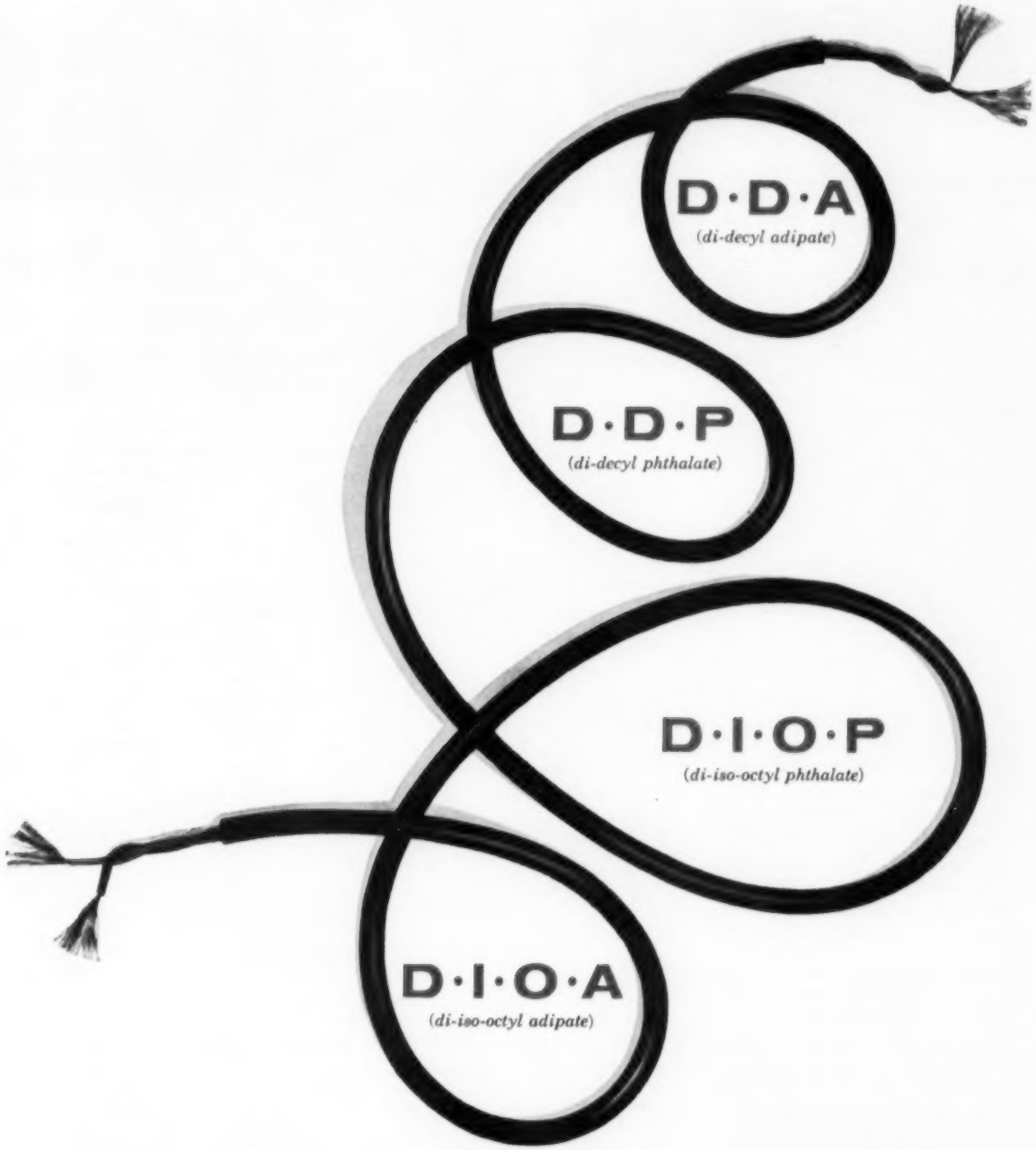
Copies of Chemical Safety Data Sheet SD-53, Hydrogen Peroxide, may be obtained from the association at 30¢ each.

CreZon

Announcement has been made by Crown Zellerbach Corp., 343 Sansome St., San Francisco 19, Calif., that the company will continue its efforts during 1956 to convince the plywood industry and users of plywood that exterior applications can be increased from ¾- to 2-billion sq. ft. annually by using its plastic overlay, designated CreZon.

CreZon is a combination of wood fibers and phenolic resin. It is shipped in rolls to plywood mills where, under intense heat and pressure, it is fused to plywood. The finished product is weatherproof and makes possible a permanent finishing job.

The company is advertising in trade publications slanted to builders, architects, general contractors, prefabricators, and other groups likely to be ultimate users; continuing publicity, direct mail, and personal contact will also be



Look to ENJAY for better iso-octyl and decyl alcohols for better plasticizers

Sebacates... Phthalates... Azelates... Adipates

All of these high-quality, uniform plasticizers were originally developed from Enjay iso-octyl and decyl alcohols and are conveniently available under the brands of leading plasticizer manufacturers.

More and more—superior plastics are being made with these effective and economical plasticizers.

Be sure of dependable high quality—ask *your supplier* for these plasticizers made from Enjay Alcohols. Enjay and its affiliates do not manufacture plasticizers.

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ENJAY IS THE PIONEER AND THE WORLD'S LARGEST SUPPLIER OF ALCOHOLS BY THE OXO PROCESS

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important elements in the program.

The advertising will stress the uses of CreZon fused plywood for exterior siding or interior built-ins. Crown feels that many new uses will be discovered during 1956 and intends to cooperate with the industry in developing ideas.

Expansion

The Borden Co., 350 Madison Ave., New York 17, N. Y., has acquired the capital stock of **American Resinous Chemicals Corp.**, Peabody, Mass., and **Reslac Chemicals, Inc.**, Chicago, Ill. **Augustine R. Marusi** vice president of Borden's, states that the acquisitions were made to further diversify Borden's activity in thermoplastics. There will be no changes in management, operating procedure, or personnel.

The two chemical firms manufacture a varied line of products in the resins and plastics fields which includes synthetic resins for paints, varnishes, plastics, adhesives, and other materials. They also produce organosols, plastisols, and polymer solutions for surface coatings.

Spencer Chemical Co., Dwight Bldg., Kansas City 5, Mo., will build a new chemical research center southwest of Kansas City in suburban Johnson County, Kans. The research center, which is expected to be completed by the spring of 1957, will be devoted to the research and development of new and improved products in the general fields of industrial and agricultural chemicals and plastics.

Kenneth A. Spencer, president, states that the research center, which will be erected on a 40-acre site, will initially house 100 to 125 persons who will be under the direction of **Dr. John R. Brown, Jr.**, managing director of research and development. About half of these people will be professionally trained chemists and engineers; the balance will be technicians and clerical help. He asserts that future expansion of these research facilities might bring the total personnel to 150 or 200 in five to 10 years.

The location of the center in Kansas City is in keeping with the policy of centralizing various company functions in Kansas City where the firm maintains general offices. In addition, the location makes accessible the Midwest Research Institute as well as the Linda Hall Library, which has one of the nation's large collections of technical reference material. At the present time the chemical research laboratories are located at Spencer's Jayhawk Works, 20 miles south of Pittsburg, Kans.

Fiberfil Corp., Warsaw, Ind., announces the expansion of its plant which produces Fiberfil styrene and Fiberfil nylon glass-reinforced molding compounds. The company states that the new facilities will produce Fiberfil styrene at a rate of more than 400 million lb. a year and that production capacity of Fiberfil nylon will be more than tripled.

Loma Plastics, Inc., 3000 W. Pafford St., Ft. Worth, Texas, announces that another phase of its $750,000 expansion program has been completed with the addition of 25,000 sq. ft. of warehouse area and 2000 sq. ft. of office space. The firm's warehouse capacity has been more than doubled by the additional space.

Wilson Plastics, Inc., 1531 Milan Rd., Sandusky, Ohio, manufacturer of polystyrene wall tile, has formed two new corporations—**Wilson Plastics of Missouri, Inc.**, and **Wilson Containers, Inc.** The new expansion will double the size of operations and diversify the firm's activities.

Wilson Plastics will be a new manufacturing subsidiary in Missouri. Wilson Containers will cover a new field for the parent company and will be concerned initially with the manufacture and sale of plastic containers.

The initial manufacturing of containers will be in Sandusky at **Midland Plastic Molding Co.**, and, as the market expands, it is expected that further production facilities will be set up in the company's other three manufacturing plants in Jacksonville, Fla., New Windsor, N. Y., and at the new plant in Missouri.

Reiss Associates has broken ground for a new 2½-acre plant on a 12-acre site at Lowell Industrial Park, Lowell, Mass. A plastic trowel and a large plastic cylinder containing commemorative documents of the occasion were placed in the cornerstone.

Reiss began its plastics operations in Newton, Mass., in 1947 with 20 employees and 10,000 sq. ft. of space. The new plant occupies an area of 104,000 sq. ft. and will emplcy over 300 persons. The latest type laminating equipment, including high-velocity impregnators developed by the firm's engineering staff, will be installed. Reiss' affiliates in Sao Paolo, Brazil, and in Spain will assist in the manufacture of Railite, a high-pressure decorative laminate.

Company notes

B. F. Goodrich Co., Marietta, Ohio, announces that **Francis E. Weisend**, formerly plant engineer, has been promoted to plant manager of the Plastics Products Div. plant. He joined BFG in 1938 as an engineer in the physical testing laboratory at Akron, Ohio. **E. Wilbur Johnson** replaces Mr. Weisend as plant engineer. **Joe W. Misamore** has been named advertising and sales promotion manager of the division. The Plastics Div. manufactures Koroseal materials, including vinyl upholstery, film for use in the production of shower curtains and raincoats, and rigid vinyl pipe.

Celanese Corp. of America announces that **Samuel B. McFarlane** has been named laboratory

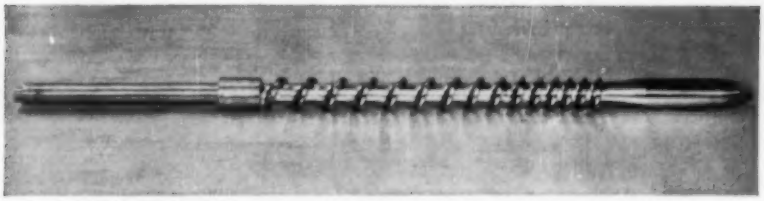
DOW

Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

PLASTIATRICS HELPS YOU CHOOSE AND USE PLASTICS CORRECTLY

Are you getting the most out of the plastics you need? Do you have the best or the latest for your money? Are you satisfied that plastics are right for the job? That's where *Plastiatrics* comes in . . . to provide a continuous study, analysis and treatment of plastics . . . to understand, prevent or cure plastics problems. Dow, which produces polystyrene under the trade name Styron®, conducts studies in many fields of plastics. For example, continuing studies are undertaken on extrusion. These are of significance to engineers and plastics molders.



DOW'S STUDIES ON IMPROVED SCREW AND TORPEDO DESIGN HELP MAKE POLYSTYRENE EXTRUSION A MORE EXACT SCIENCE

Studies for the development of a better screw and torpedo from polystyrene extrusion are good examples of Plastiatrics at work. Manufacturers using machines equipped with a single flight screw and torpedo arrangement like this one shown here can profitably extrude high-quality polystyrene and get uniformly good results. One thing that was found in working out the details of this better screw was that single flight eliminates blocking in one channel and flowing in another, a problem of the double flight screw that more often than not produces wide variations in product output.

Further studies of the torpedo have led to extensive findings, relative to the use of the torpedo screw, which are available by simply writing Dow.

Standard pressure gage studies another area of Plastiatrics development

Extensive Plastiatrics studies in extrusion have been made on the proper design of dies, take-off equipment and cooling problems. Dow engineers, together with plastics manufacturers, also developed a method for determining optimum pressure and for providing reproducible extrusion performance using a standard gage.

Write for free bulletins

Detailed results of Dow's studies on extrusion are available to you, as they are on all work done in Plastiatrics. For further information, write today . . . Dow Plastics Sales Department PL 456R, THE DOW CHEMICAL COMPANY, Midland, Michigan.

DOW POLYSTYRENE FORMULATIONS:

- Styron® 666 . . . Dow general-purpose polystyrene.
- Styron 688 . . . for controlled flow and controlled pressure distribution in the mold cavity.
- Styron 777 . . . for medium-impact strength.
- Styron 475 . . . for high-impact strength and high elongation.
- Styron 475 sheet . . . for vacuum or pressure forming.
- Styron 480 . . . for extra-high-impact strength.
- Styron 700 . . . for high heat resistance.
- Styron 683 . . . for medium-high heat resistance.

you can depend on DOW PLASTICS

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manager of its Summit, N. J., plant. He will be in charge of the research facilities and services provided by the Summit laboratories for the three Celanese operating divisions—textiles, plastics, and chemicals. **Dr. Oren V. Luke, Jr.** is the new manager of the Plastics Research Dept. He was transferred to Summit in 1954 from **Celanese Petroleum Chemicals Research and Development Laboratories** in Clarkwood, Texas.

Witco Chemical Co., 122 E. 42nd St., New York 17, N. Y., reports the following appointments: **Robert I. Wishnick,** formerly president, has become chairman of the board and chief executive officer of the company; **Max A. Minnig** has been elected president to succeed Mr. Wishnick; and **William Wishnick** replaces Mr. Minnig as executive vice president.

B. F. Goodrich Chemical Co. announces the following promotions at its Avon Lake, Ohio, general chemicals plant: **Owen F. Beckmeyer** has been named plant manager; **Vert C. Fraser,** production manager; and **Richard W. McKay,** technical manager. **Robert D. Scott,** vice president of manufacturing, states that the moves were a result of the recent appointment of the former Avon Lake general chemicals plant manager, **D. L. Matthews,** as chief engineer of **Goodrich-Gulf Chemicals, Inc.**

W. R. Grace & Co., 3 Hanover Sq., New York 4, N. Y., reports that **Hugh S. Ferguson,** president of Dewey and Almy Chemical Div., has been named executive vice president in charge of the Chemical Group in the parent company. The Chemical Group includes four divisions—Dewey and Almy Chemical Co., Davison Chemical Co., Grace Chemical Co., and Grace Chemical Research and Development Co. Until this appointment, responsibility for directing Grace chemical activities was exercised by **Charles E. Wilson,** chairman of the board. Mr. Ferguson, who became president of Dewey and Almy in January 1953, will continue in that capacity.

The Dow Chemical Co. has opened a sales office at 70 Niagara St., Buffalo, N. Y., to service a territory that covers a substantial part of New York state and a section of northwest Pennsylvania. This is Dow's sixteenth office located in major cities throughout the United States.

Eugene L. Martinez, formerly general chemicals salesman at Dow's New York City office for about 10 years, has been named manager of the new office. The sales staff includes two chemical salesmen—**Seward H. Mott, Jr.** and **Gerald L. Mitchell**—and four plastics salesmen—**Ross D. Visger,** plastics supervisor; **Robert F. Bunker, Robert S. Crew,** and **Donald W. Ruoff.**

Ohio-Apex Div., Food Machinery and Chemical Corp., Nitro, W. Va., announces that **Dr. Charles A. Heiberger** has been transferred to the Central Research Laboratory as manager of the Plastics and Polymers Dept. of Food Machinery. **Paul E. Willard,** formerly assistant director of research of Ohio-Apex has been named director of research.

Phillips Chemical Co., wholly owned subsidiary of **Phillips Petroleum Co.**, Bartlesville, Okla., will establish a new district office for its Plastics Sales Div. in Akron, Ohio. **W. M. Larsen** has been named manager of the office. The Akron district office, which will be opened in the spring, is the fifth such office announced in recent weeks as the company prepares to meet the expected demand for Marlex. Production of Marlex polyethylene is scheduled to begin in mid-1956 at the firm's Adams Terminal plant site on the Houston Ship Channel near Pasadena, Texas.

Phillips also announces that the staff of its New York plastics sales office is being enlarged by the appointment of **M. B. Bistline** as sales engineer under **W. C. Douce,** district manager. Mr. Larsen was formerly marketing assistant in the parent company's Sales Dept. and Mr. Bistline was a development engineer in the Research and Development Dept.

Interchemical Corp., 67 W. 44th St., New York 36, N. Y., announces the following appointments: **Virgil W. McDaniel** has been named division president of the company's Cotan Div., manufacturer of coated fabrics in Newark, N. J. He succeeds **C. T. Melvin,** head of Cotan since 1938, who has retired from active management but who will continue in a consulting capacity. **Robert L. Lewis,** Cotan vice president of production, has been assigned greater responsibilities in this activity. **Russell F. Tandy** will head a newly-formed Development Dept. and **John Kuser** has been named assistant sales manager.

Cadillac Plastic & Chemical Co., Detroit 26, Mich., has opened a combined warehouse-office at 652 Polk St., San Francisco, Calif. **Ted Harrigan** has been named manager of the new unit. He will be under the supervision of **Eugene Quinn,** manager of the Los Angeles branch.

The new warehouse will carry a complete stock of thermoplastic sheets, rods, and tubes in acrylic, vinyl, acetate, nylon, Tygon, Teflon, polyethylene, and other materials.

The company's first West Coast branch was opened in Los Angeles in August 1954. Sales for the first 13 months (ending September 30, 1955) were in excess of $500,000.

Plectron Corp., Overton, Neb., is the new name of the company formerly known as Metal-Plastics Co.

Loma Plastics, Inc., 3000 W. Pafford St., Ft. Worth, Texas, reports the following appointments:

Milton Hamill has been named production manager; **R. E. Partridge,** plant manager; **Mitchell Vuksonovich,** plant molding superintendent; and **Paul Gunn,** coordinating engineer.

General Electric Co. announces that **William F. Christopher** has been appointed manager of market development of G-E's Chemical Development Dept. in Pittsfield, Mass. **John T. Castles** has been appointed manager of the Elastomer Market Development Unit in G-E's Silicone Products Dept. in Waterford, N. Y.

Product Packaging Engineering, Culver City, Calif., manufacturer of automatic packaging machines and heat sealing equipment has appointed **Standard Supply Co.,** 148 State St., Hartford, Conn., and **Herman & Leal,** 468 McGill St., Montreal, Que., as sales representatives. Among other machinery, Product Packaging produces the Comet 54 series of semi-automatic heat sealers which seals coated or laminated barrier materials to government or commercial specifications.

L.O.F. Glass Fibers Co., Toledo 1, Ohio, has created a new automotive division for sales and service activities in fibrous glass products. The division will be headed by **Clinton F. Hegg,** vice president, who has been in charge of the Textile Div.

J. M. Johns, vice president and director of sales, states that the company had spent five years of pioneering in the development of safety padding for the dashboard and instrument areas of modern passenger cars and had been active in production of such items in the past two years.

Ray-O-Lite Corp. of America has opened a new western division office at 10824 Fawcett St., El Monte, Calif., to be headed by **Robert J. Considine.** The company, which maintains headquarters in Atlanta, Ga., fabricates fibrous glass awnings and other fibrous glass specialties.

Reichhold Chemicals, Inc., White Plains, N. Y., announces that **Waverly W. Moore** has been named as sales representative to handle the southern states. **William T. Marshall** has joined the company's New Orleans, La., sales office. He was formerly associated with C. T. Patterson Co., New Orleans.

St. Regis Paper Co. reports that **Eli Hartz** has been appointed manager of the Panelyte Div.'s vacuum forming plant at Richmond, Ind. He formerly served as chief engineer of the Panelyte plant at St. Jean, Que. **Jack Sibalis** succeeds Mr. Hartz as chief engineer at St. Jean.

Acheson Dispersed Pigments Co., 2250 E. Ontario St., Philadelphia 34, Pa., a unit of Acheson Industries, Inc., announces that **Edward T. Butler** has been named general sales manager. He was formerly sales manager of Diamond Alkali Co.'s Plastics Div. **H. G. Robinson** has been appointed works manager of the Philadelphia Works. He has been acting as production manager of the Philadelphia Works and will continue in that function.

Reed-Prentice Corp., Worcester 4, Mass., reports that **J. Joseph Kelly,** formerly general sales manager, has been raised to vice president in charge of sales and that **Frederick W. McIntyre, Jr.** has been promoted to vice president and works manager.

Lustra-Cite Industries, Inc. has consolidated its plants and offices, which were located in three different locations, in a new building at 331-35 Kent Ave., Brooklyn, N. Y. The company's new building occupies 28,000 sq. ft. of manufacturing space.

Owens-Illinois Glass Co., Toledo, Ohio, announces that **Edward A. Randlett** has been appointed southeastern closure and plastics manager, with headquarters in Memphis, Tenn. **R. M. Curtis,** formerly assistant service manager of the company's Glassboro, N. J., plant, has been named western closure representative.

Mechtronics Co., 423 W. Coulter St., Philadelphia 44, Pa., is the new name of the firm formerly known as Semond Levitt Engineering Services. Mechtronics offers services in the fields of reinforced plastics, automation, mechanical engineering, and electronics.

Ideas and Their Production, Bendix Bldg., 1206 So. Maple Ave., Los Angeles, Calif., recently formed, is headed by **Martin Hill Coffler.** Mr. Coffler was formerly advertising manager of L. H. Butcher, Los Angeles, and Rezolin, Inc. He will continue to represent Rezolin.

Trenton Plastics Laboratories, Inc., 1640 E. State St., Trenton, N. J., has been recently formed to produce custom formulated epoxy and modified epoxy resin compounds to serve the electrical industry. These epoxy systems are being used extensively for potting, encapsulating, impregnating, and casting applications of electrical components. The company is producing a complete line of industrial adhesives, caulking, and coating compounds for marine uses, in addition to repair units of resin and fibrous glass for boats, automobiles, and other similar applications.

Radiant Heat Enterprises, Inc., 623 Morris Ave., Springfield, N. J., is a new organization formed by a group of sales and engineering associates formerly with Sill Industries. The group includes **Thomas F. Walsh,** sales manager; **Chung Sheng Na,** textile engineer; and **Bruce Boden.** The company is marketing the electro-ceramic radiant heater designed by Mr. Boden, which was introduced to the field in 1953. The heater is the basic unit in the stabilizing, drying, and curing systems which Radiant builds for industry.

Soule Mill, New Bedford, Mass., which was recently purchased by **United Industrial Syndicate, Inc.,** will operate as an independent subsidiary of that company, according to **Joseph A. Dancewicz,** former general manager of Soule, who heads up the new management. Soule produces a full glass fabric line for the electrical, reinforced plastic, coated, decorative,

The Plastiscope

and insect screening markets. Peter W. Duff will be head of sales of the company, with headquarters in New York, N. Y.

Hungerford Plastics Corp., Rockaway, N. J., announces the opening of a permanent showroom at the Toy Center, 200 Fifth Ave., New York, N. Y. A Walt Disney licensee, Hungerford has introduced a broad line of Disney character dolls and numerous creations of its own all-vinyl dolls.

In addition, a line of squeeze toys is being tooled for the Toy Fair.

Personal

Dr. Lawrence E. Nielsen has been named a senior scientist of **Monsanto Chemical Co.**, Springfield, Mass. A physical chemist at Monsanto's research laboratories, Mr. Nielsen has initiated and guided a broad research program dealing with the mechanical properties of polymers and their relationship to molecular structure. Monsanto has created the position of senior scientist to allow scientific personnel to progress to maximum levels within the company without having to engage in administrative activities. Senior scientists are given maximum freedom in planning and carrying out research; they serve in a consultant capacity to all divisions of the firm.

Charles H. Carpenter, Jr. has been named assistant manager of the Market Development Dept. of **Metal & Thermit Corp.**, 100 E. 42nd St., New York 17, N. Y. Mr. Carpenter comes to Metal & Thermit from American Cyanamid Co., where he served as senior market analyst.

William Brown, advertising manager, has been appointed to head sales of the new program of consumer goods of **National Vulcanized Fibre Co.**, Wilmington, Del. The consumer goods program is part of a long-range plan of diversification by the company. A line of housewares has been produced from vulcanized fibre, designed by Donald Deskey Associates.

Berkley V. Schaub, vice president and director of **National Adhesives (Canada) Ltd.**, Toronto, Ont., was elected president of the Canadian Packaging Association for 1956 at the annual meeting.

H. Seymour Colton has resigned as president of **Colton Chemical Co., a Div. of Air Reduction Co., Inc.**, Cleveland 14, Ohio, to become president of **Macco Chemical Co.**, 30404 Lakeland Ave., Wickliffe, Ohio, with offices at 1410 Schofield Bldg., Cleveland, Ohio. Mr. Colton has left the Colton firm to develop new ideas, new products, and new enterprises in the field of chemistry. Colton Chemical, which he founded in 1943 under the name of Special Chemicals Co., was sold to Air Reduction in 1954.

Macco now manufactures mastic used in attaching plastic tile.

In 1955 Colton Chemical, one of three manufacturers in the polyvinyl alcohol field and also a producer of emulsions, climbed into the multi-million dollar sales volume class.

Ira M. Schafer has been assigned to the technical staff of **Federal Latex Corp., a Div. of Federal Adhesives Corp.**, 210 Wythe Ave., Brooklyn, N. Y., producer of liquid and dry glues, pastes, resins, and latex adhesives.

Raymond V. Shear, formerly production manager, is now assistant general manager of **DuBois Plastic Products, Inc.**, 168-78 Florida St., Buffalo 8, N. Y.

E. W. Maas, who has had 27 years' experience in the plastics industry, has established a consulting service in East Hampton, Conn., P. O. Box 73. His experience includes service with Du Pont, National Vulcanized Fibre Co., and American Optical Co. Mr. Maas is prepared to offer consultation in the fields of product and tool design, equipment and processing studies, cost reduction, and many other phases of molding, extrusion, forming, casting and high- or low-pressure laminating.

Joseph T. Marie has been named sales office manager of **Davis-Standard Sales Corp.**, Mystic, Conn. Mr. Marie's new assignment will include responsibility for the coordination of all sales activities of Davis-Standard, which is the sole selling agent for The Standard Machinery Co. The firm handles a complete line of wire machinery and extruders for rubber and plastics, including the Therma-Fin extruder.

Ted Barks, formerly of Monsanto Chemical Co., has been appointed plant manager of **The Pantasote Co.**, Passaic, N. J.

Carl Halpin, industrial engineer, has joined **Lunn Laminates, Inc.**, Huntington Station, N. Y. Mr. Halpin will develop reinforced plastics applications for the automotive, electrical, and associated industries in the Detroit, Mich., area.

William E. Ford has joined the Carbon Black Sales Dept. of **Columbian Carbon Co.**, 380 Madison Ave., New York, N. Y. He will be associated with the company's Akron, Ohio, office.

Hans Wyman has been elected president of **The Eleonora Chemical Corp.**, a newly formed subsidiary of **The Pantasote Co.**, Newark, N. J., and 444 Madison Ave., New York, N. Y. The company will produce polyvinyl chloride. Eleonora's new plant, which is being constructed by Scientific Design Co., Inc., is scheduled for completion by the end of 1956.

Thomas G. Bishop has been promoted to sales manager of **The Hydraulic Press Mfg. Co.'s** Plastic Machinery Div., Mount Gilead, Ohio. Mr. Bishop returns to the company's headquarters after

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serving several years as assistant manager of H-P-M's Teaneck, N. J., eastern office, where he was in charge of plastic machinery sales.

Dr. Robert S. Aries, president of **R. S. Aries & Associates,** 270 Park Ave., New York, N. Y., and part-time member of the graduate faculty of the Polytechnic Institute of Brooklyn, has been elected a fellow of the New York Academy of Sciences.

Leo J. Dross has joined **Goodall Fabrics, Div. of Burlington Industries,** 1430 Broadway, New York, N. Y., as a sales agent in the southwest. He will solicit all trades using vinyl-coated materials, including jobbers, the upholstered furniture, and automotive fabric accessory trades. Mr. Dross' headquarters will be at 14 Still Forest Dr., Houston, Texas.

John H. Leary has been appointed mid-Atlantic district manager of **Hull Standard Corp.,** Abington, Pa., manufacturer of vacuum processing systems (dryers, impregnators, metallizers, etc.). Mr. Leary was formerly manager in charge of vacuum impregnating and drying equipment.

Louis H. Barnett, president of **Loma Plastics, Inc.,** Fort Worth, Texas, has received a certificate of merit awarded to his company by Dallas and Ft. Worth business men for outstanding achievement in management improvement.

H. Ernie Renner has joined **Plastic Age Sales, Inc.,** 651 Arroyo Ave., San Fernando, Calif. Mr. Renner comes to the firm with 12 years of experience in the reinforced plastics field.

Morton B. Gilbert has joined the Chicago, Ill., district staff of **F. J. Stokes Machine Co.,** Philadelphia 20, Pa., as a sales engineer. Mr. Gilbert was formerly associated with Central Scientific Co. and Consolidated Vacuum Corp.

John A. Sherred, formerly director of research development of **Monsanto Chemical Co.'s** Plastics Div., has been transferred to the **Lion Oil Co. Div.** at El Dorado, Ark., where he will be director of development.

J. Harmer Rile, Jr. has retired as a sales manager of **Cellulose Products Dept., Hercules Powder Co., Inc.,** Wilmington 99, Del., after 38 years' service with the company. Mr. Rile guided the sale of nitrocellulose during the years when it developed to its present wide use in lacquer, plastics, and industrial protective coatings.

Donald B. Schaumburg has been appointed to the newly created post of controller of **Holiday Plastics, Inc.,** 1301 Fairfax Traffic Way, Kansas City, Kans. Mr. Schaumburg until recently was tax manager of Spencer Chemical Co., Kansas City, Mo.

Deceased

Raymond J. Olson, vice president in charge of production of **Federal Tool Corp.,** Chicago, Ill., was fatally injured in a motor car accident. Mr. Olson had been associated with the company for 13 years. Severely injured in the accident, which also claimed the life of another man, was **Keith Williams** of **Dow Chemical Co.'s** Chicago, Ill., office.

Frank E. Payne, chairman of the board and co-founder of **Crane Packing Co.,** Chicago, Ill., and Hamilton, Ont., manufacturer of Teflon products and pipe joint compounds, died at the age of 72.

Meetings

Plastics groups

March 8-9: The Society of the Plastics Industry Canada, Inc., Fourteenth Annual S.P.I. Canadian Conference, Sheraton-Brock Hotel, Niagara Falls, Ontario, Canada.

March 27: The Society of the Plastics Industry, Inc., Pacific Coast Section, Annual Meeting, San Francisco. Other meetings aboard ship, Mar. 28-Apr. 2.

June 11-15: The Society of the Plastics Industry, Inc., Seventh National Plastics Exposition, New Coliseum, New York, N. Y.

Other meetings

Feb. 26-29: American Institute of Chemical Engineers, Hotel Statler, Los Angeles, Calif.

Feb. 27-March 2: American Society for Testing Materials, National Meeting,, Hotel Statler, Buffalo, N. Y.

March 5-7: Packaging Association of Canada, National Packaging Convention, King Edward Hotel, Toronto, Ont.

March 19-23: American Society of Tool Engineers, Annual Industrial Exposition, International Amphitheatre, Chicago, Ill.

April 3-9: Commission on Macromolecules of the International Union of Pure and Applied Chemistry and The Weizmann Institute of Science, Rehovot, Israel. Subjects include: "General Behavior of Polymers in Solution," "General Behavior of Biocolloids and Polyelectrolytes in Aqueous Solution," and "Special Polymeric Systems in Solution."

April 9-12: American Management Association, Silver Anniversary National Packaging Exposition, Convention Hall, Atlantic City, N. J.

April 10-12: Point-Of-Purchase Advertising Institute, Inc., Tenth Annual Symposium and Exhibit, Hotel Sheraton-Astor, New York, N. Y.

April 23-28: Manufacturing Chemists' Association, Inc., Third Annual Chemical Progress Week.

April 23-May 3: British Industries Fair, Olympia Hall, London, and Castle Bromwich, Birmingham, England.

May 14-17: Clapp & Poliak, Inc., Conference and First Design Engineering Show, Convention Hall, Philadelphia, Pa.

Outdoors two years—and PARAPLEX P-444 looks as good as ever

Two years ago, a test panel made of PARAPLEX P-444 polyester resin and glass fiber and a similar test panel based on a conventional polyester resin were placed on the roof of an isolated building. Today, after two years of continuous exposure, the panel based on PARAPLEX P-444 is still highly transparent and is not discolored. Fiber evidence, too, is as slight as in the original sample. The panel based on the conventional resin, on the other hand, has lost much of its transparency, and fibers and discoloration are quite evident.

PARAPLEX P-444 polyester-acrylic resin offers to manufacturers of corrugated panels, flat sheets, awnings and decorative sidings these advantages:

- excellent wetting of and adhesion to glass fibers
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For more details on PARAPLEX P-444 and other Rohm & Haas polyester resins, write to Department WEW-1-6.

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FOR SALE: (11) 75 ton record presses, complete @ $2,450, (11) new 100 ton, 10" ram, 10" stroke @ $1,100, (8) 200 ton, 9" stroke, 14" ram, 36x36 @ $1,850, (7) 200 ton, 9" stroke, 15" ram, 30x30 @ $1,650, (1) 50 ton complete, 18x18 @ $1,850, (1) 200 ton, 16" ram, 30x30 @ $2,450, (2) 200 ton, 16" ram, 42x42 @ $2,850, (1) 200 ton, 15" ram, 42x42 @ $2,450, (4) 250 ton, (2) 12" rams. 30x60 rebuilt @ $3,375. Hydraulic Sal-Press Co., Inc., 388 Warren Street, B'klyn, N. Y.

FOR SALE: 3—Ball & Jewell #2, #1½ Rotary Cutters; 1—Cumberland #0 Rotary Cutter; 4—Two Roll Mills 20"x22"x60", 15"x40", 6"x14"; 3—Baker Perkins 100 gal. 50 gal., 2 gal., jacketed double arm Mixers; 1—Stokes Rotary Preform Press #DDS2; 3—Stokes Model "R" single punch Preform Presses; 1—Kux Model 15-25 Rotary Press; Also: Sifters, Banbury Mixers, Powder Mixers, etc., partial listing; write for details; we purchase your surplus equipment; Brill Equipment Co., 2407 Third Ave., New York 51, N. Y.

FOR SALE: 1—Royle #4 Extruder, motor driven; 1—6" x 12" Laboratory Mill, m.d.; 1—Ball & Jewell Rotary Cutter, size O m.d.; 2—Baker-Perkins Size 15, 100 gal. Jacketed Mixers; 5—Horizontal Dry Powder ribbon Mixers, 4000#, 1500#, 500#; 1—New 3 Roll 6"x16" Laboratory Calender; 1—Farrell-Birmingham 60" Mill with reduction drive, 150 HP motor, floor level mounting; 1—Fitzpatrick "D" Comminutor, S.S. contact parts, jacketed; 1—Mikro Pulverizer #2th, with motor; 4—Reed-Prentice & W-S Injection Molding Machines, 2-16 oz.; Also other sizes: Hydraulic Presses, Tubers, Banbury Mixers, Mills, Vulcanizers, Calenders, Pellet Presses, Cutters. Send us your inquiries. What have you for sale? Consolidated Products Co., Inc., 50 Bloomfield Street, Hoboken, N.J. HOboken 3-4425, N.Y. Tel.: BArclay 7-0600.

FOR SALE: Six 15 ton Stokes automatic molding presses Model 200D2, $800 each, two 350 ton Transfer Presses complete like new, $125.00 each, two 75 ton Watson-Stillman presses complete, $2500 each, two Hartig Plastic Extruders—one 3½ $3100; one 4½ inch $3800, each complete with oil pre-heating tanks and motors. Reply Box 5026, Modern Plastics.

SAVE With Guaranteed Rebuilt Equipment: Hydraulic Presses: Compression Molding Dunning & Boschert 2—12" ram 170 tons; 2—10" ram 118 tons; Wood 20"x20" 170 tons; Southwark 24"x24" 170 tons; Baldwin Southwark 4—26"x26" 8" ram 75 tons; 5—26"x26" 7" ram 57.7 tons; 5—15"x15" 8" ram 75 tons; 4—14"x14" 8" ram 75 tons; 2—19"x24" 10" ram 78 tons; 18"x18" 7" ram 57.7 tons; 3—12"x12" 7½" ram 66 tons; 8"x9" 4½" ram 24 tons. D&B 12"x12" 3" ram 10 tons; Transfer Molding 75 tons; Preform Presses 5½ T Colton and Stokes R, M.D.; Universal dual pumping units, 3—15 H.P; laboratory mills and calenders, also extruders, mixers, vulcanizers, injection molding units, etc. Universal Hydraulic Machinery Co., Inc., 285 Hudson Street, New York 13, N. Y.

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FOR SALE: 1 Stokes preform press Model 294, Series 5, 60 Ton, complete with variable drive 220-440 Volts 60 cy. three phase. 1—300 ton French Oil compression press, maximum mold space L-R X F-B 26x28. Maximum daylight opening, 30", Maximum Between Grids, 12", Maximum Ram Travel, 12", Size of Ram, 22". 1 5 hp type sax 250# Kane Boiler # Equipped with Electric Hi-Lo Modulation. 1 Style #7TT5Z MKO Automatic Boiler Feed #3424 3 hp 440/60/3 & Starter. Paramount Die Casting Company, St. Joseph, Michigan.

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(*Continued on page 274*)

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Thermomat CO., Inc. 300 MAPLE AVENUE, TRENTON 8, N. J.

(*Continued from page 272*)

PELLETIZERS FOR SALE.
1—Cumberland pelletizer in very good condition. 1—Heavy duty Mitts & Merrill pelletizer, practically new, used only for a few hours.
Roart Co.
830 Monroe St.
Hoboken, N. J.

FOR SALE: 2—880 ton self-contained compression presses; 1—Wood 30 ton self-contained press; 1 National Erie 8½" strainer; 1 NRM 4½" oil heated plastics extruder; 1—6x12" lab mill; also mixers, cutters, grinders, presses, etc. Chemical & Process Machinery Corp., 52 Ninth Street, Brooklyn 15, N. Y.

FOR SALE: Injection Molding Machines, 16 oz. 1951 HPM, 12 oz. 1947 W-5, 8 oz. 1946 Lester, 4 oz. 1952 Lester—Die Hobbing Presses 150 ton to 1000 ton. Partial Listing—Many more items—Send us your inquiries. Plastic Machinery Exchange, 426 Essex Avenue, Boonton, N. J., telephone Deerfield 4-1615, cable address "Plasmex, Boonton".

FOR SALE: Injection Presses: 4, 8, 12, 24 oz. Reeds, 2, 9 oz. HPM, 32 oz. Vertical HPM, 8, 12, 20 oz. Lesters, 1, 2 oz. Van Dorn, 4 oz. Lewis, 12, 48 oz. Watson. Extruder: 6" Hartig complete Pipe Extrusion setup, Stokes-Windsor RC 65 Twin Screw Extruder. Cumberland 0 & 1 Granulator. 7" Stair—Step Dicing Mach.—Ovens—Temp. Circulators—48" Stokes Vacuum Metallizer Setup. 6"x12" Lab. Mill. Markem Imprint. Mach. No. 25 A.—Compression Presses 50 to 600 Tons. 15 T. Stokes Automatics. Stokes No. 294 & Kux No. 60 Preform presses. 30 HP Oilboiler. Auto-Vac 52"x30" Vac. Form. Mach. 200 T. Hobbing Press. 24 & 16 Carrier Braid. Mach.—All Midwest locations. List your Surplus Equipment with me. Justin Zenner, 823 Waveland Ave., Chicago 13, Ill.

FOR SALE.
#3-oz. Fellows Injection Molding Press, 1953 Model. In splendid condition. Price is $8,000.00.
Molderaft Products, Inc.
1505 W. 41st Street
Baltimore 11, Maryland

FOR SALE: Hydraulic Presses: Baldwin-Southwark 3600 Ton Belt Press. Elmes 1000 Ton Hobbing Press. MD Pump. HPM 750 Ton, Down-acting, Self-contained. Farrell 625 Ton, Self-contained. Watson-Stillman 600 Ton Hobbing Press, MD Pump. Farrell 393 Ton, Double-Opening. Elmes 350 Ton, Down-acting, Self-contained. Lake Erie 215 Ton, Self-contained, Semi-automatic. Farquhar 100 Ton, Down-acting, Self-contained. Watson-Stillman 100 Ton. HPM 35 Ton Molding Presses. Watson-Stillman and Elmes 30 Ton and 20 Ton Lab Presses. Stokes Model 200-D2 Automatic and Stokes, 300, 200, 150 and 100 Ton Semi-automatic Presses. Injection Machines: De Mattia Model B-24 Oz. HPM Model 350-H-16, 16 Oz. Reed-Prentice, 12 Oz., 1952 Machine. Watson-Stillman 2 Oz. Van Dorn Model H-200, 1 Oz.; Tablet Machines: Stokes S-5, R. T. RDS-3; Colton #5, #5½, 2-RP and 3-RP. Mills: 4—Farrell 18"x50"; 4—Farrell 16"x40"; 2—Farrell 15"x36". Available as Mill Lines or as Individual Units. Extruders: Royle Nos. 1, 2, 3, and 4. Allen-Williams 8"—All Individual Motor Drive. Calender: Stewart Bolling 6"x16", 3 Roll, 10 HP DC Variable Speed M.D. Miscellaneous: Vulcanizers, Calenders, Scrap Cutters, Pumps, Valves, Platens, Etc. Johnson Machinery Company, 683-M Frelinghuysen Avenue, Newark 5, New Jersey. Bigelow 8-2500. What Have You For Sale? What Are You Looking For?

Machinery and equipment wanted

WANTED: Used Hydraulic Presses for fiberglass—in good condition—Working areas from 48"x60" to 96"x120"—300 to 1000 ton. State condition and price—Reply Box 5022, Modern Plastics.

WANTED.
Used Stokes 235 A automatic molding presses.
Reply Box 5012, Modern Plastics

WANTED: Compression Molding Presses, all types. Reply Box 5034, Modern Plastics.

WANTED: One used Model 18 Cumberland Granulating Machine. Reply Box 5011, Modern Plastics.

Materials for sale

FOR SALE.
15,000 lbs. Virgin White Acetate; 7,000 lbs. Virgin Transparent Pink Tinsel Acetate; 4,000 White Virgin High Impact Polystyrene; 6,000 lbs. Virgin Light Green High Impact Polystyrene; 12,000 lbs. Reprocessed Red and Yellow High Impact Polystyrene; 16,000 lbs. Reground Light Standard Colors High Impact Polystyrene; 10,000 lbs. Reprocessed Red, Green, Blue Polystyrene; 18,000 lbs. Natural & Colors Reprocessed C-11; 30,000 lbs. Black Reprocessed Polyethylene; 40,000 lbs. Transparent Red Methyl Methacrylate Taillight formulation; 8,000 lbs. Virgin Yellow Vinyl soft durometer. Samples and prices on request.
A. Bamberger Corporation
703 Bedford Ave , Brooklyn 6, N. Y.
Telephone Main 5-7450

FOR SALE: 50,000 pounds utility black Acetate. Price on request. Plastic Moulding Powders, Inc., 2004 McDonald Ave., Brooklyn 23, New York. Esplanade 5-7943.

VINYL UPHOLSTERY SHEETING: 250,000 yds., 12 gauge 54" printed vinyl plastic upholstery sheeting. Closeouts. Assorted patterns. 45¢ per yd. Write for samples. Regent Company, 443 Broadway, N.Y.C. WO 6-1343.

Materials wanted

WANTED.
Plastics Scrap and Rejects of all kinds, Ground and unground. Also rejected molded pieces and surplus virgin molding powders. Top prices paid.
A. Bamberger Corporation
703 Bedford Ave., Brooklyn 6, N. Y.
MAin 5-7450

WANTED: Plastic Scrap. Polyethylene, Polystyrene, Acetate, Acrylic, Butyrate, Nylon, Vinyl. George Woloch, Inc., 601 West 26th Street, New York 1, N. Y.

PLASTIC SCRAP: Polystyrene, Hi Impact Polystyrene, Polyethylene and Acetate. Top Prices Paid. Plastic Moulding Powders, Inc., 2004 McDonald Ave., B'klyn 23, N. Y. ES 5-7943.

WANTED: Plexiglas and Lucite scrap, salvage and cut-offs, any quantity. Turn your surplus sheet stock into cash. Ask for our quotation. Duke Plastics Corp., 584 Broadway, Bklyn 6, N. Y. Evergreen 8-5520.

WANTED: Polystyrene: virgin, off color, clean reground, or reprocessed, all colors. End users. Sterling Plastics Co., 1140 Commerce Ave., Union, New Jersey.

SCRAP PLASTICS: All forms, waste and surplus plastic molding materials, rejects in any form. We will also buy your obsolete inventories of molding powders, stabilizers, plasticizers and other plastic and chemical materials. Aceto Chemical Co., Inc., 40-40A Lawrence St., Flushing 54, N. Y. INdependence 1-4100.

Molds for sale

FOR SALE: Complete line of Houseware Molds, Comb Molds, also some novelty and specialty items. No reasonable offer refused. Send for list. Reply Box 5030, Modern Plastics.

Plants for sale

AN IMPORTANT NOTICE: To the plastics chief engineer, mechanical engineer, product designer, sales manager or executive who can form an operating group . . . or . . . the company that is a large user of plastics, and wants to own its own facilities: This is a Unique Opportunity to Buy a Profitable Plastics Plant without Paying the Owner a Penny Down! The Chance Of A Lifetime—a sweet deal like this may never present itself! Here is a modern, 71,000 sq. ft. fully equipped plant—and your ONLY cash investment is in operating capital In Your Own Business! Actually, only a moderate outlay is required—$100,000—to be added to present working capital of $200,000, for expansion and new product development. Balance of the purchase price is to be paid over the years from earnings out of future sales and profits of the business, until purchase price is fully paid up. In Other Words—This Means You Are Paying for the Business Out of the Profits You Will Make. A Modern Setup—Complete And In Good Working Shape. Plant includes 23 modern injection molding machines, up to 200 ounce capacity, also extrusion—all in top condition, half of them only 3 years old. There's a complete tool room—painting and assembly. Plant is staffed with a top-notch crew that has everything under control. (Plant incidentally, is evaluated at only 50% of its actual worth). Optional Deals! Present vice president will purchase up to 25%. Note—this is a prosperous, mid-west business with a large volume operation, and even larger potential. Only reason for the sale is owners' desire to retire from active management. They will, however, continue as long as needed. Plant is for immediate sale, and **the right buy** (with long terms), for experienced plastics men who want a future, not a job; or company that wants to own its own facilities. (All inquiries are regarded as strictly confidential.) Get further details by writing Box 5032, Modern Plastics.

COMPLETE FILM AND SHEET PLANT available in Canada. New equipment in specially constructed building includes 4½ Hartig (Polyethylene or acetate); 5" special Banderra (polystyrene); Dusenberry 42" Slitter. All complete with dies, pelletizers, take-offs, grinders and essential supplementary equipment. Consider parcelling machinery and lease building. Reply Box 5023, Modern Plastics.

FACTORY BUILDING AVAILABLE in N. Carolina: Brick bldg. 10,000 sq. ft. Adjacent Southern R.R.; rail siding would be easy. Plenty of land all around. In city limits. Very ample water supply. Formerly a hosiery mill—knitting, dyeing & finishing. Excellent boiler, stoker fired. Plenty good labor available. Also annex stock room. Will Lease Or Sell. Reply Box 5028, Modern Plastics.

(*Continued on page 276*)

"Thermex Plastic Preheaters outstanding! ...Faster cycles, fewer rejects, less maintenance"

Says **Marvin G. Johnson,** *Supt., Sperzel Co.*

Five THERMEX* Plastic Preheating Units are used at the Sperzel Company, Minneapolis, for heating toilet seat preforms. Here is what Marvin G. Johnson, Superintendent, reports on performance:

"In over fifteen years of molding we have used several types of preheaters ... but there is no doubt that THERMEX equipment is outstanding. We find faster cycles, less rejects and greatly reduced maintenance cost have given us a far smoother and more profitable molding operation."

Studies of operating figures show that rejects were reduced 33%—an important gain since rejected material cannot be salvaged. Production rates increased 33%, and maintenance costs were cut in half!

Find out how *you* can operate more profitably with THERMEX Plastic Preheating Apparatus. Call or write The Girdler Company, Thermex Division, Louisville 1, Kentucky.

*THERMEX — Trade Mark Reg. U. S. Pat. Off.

This 7.5 kw unit can heat 6 pounds of material from 80°F to 250°F in just one minute. Power is applied automatically when the sliding drawer is closed; shuts off after a preset interval.

The GIRDLER Company

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
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THERMEX DIVISION

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239 Newton Ave., Newark, Ohio • 624 So. Michigan Ave., Chicago 23, Illinois • 714 West Olympic Blvd., Los Angeles, Calif.

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Help wanted

WANTED.
Chief Engineer for Medium Compression and Transfer Molder located in Western Pennsylvania. This is an excellent opportunity for the right man to join a young progressive company. Salary open.
Reply Box 5010, Modern Plastics

DO YOU WANT TO LIVE in Sunny California where the climate is ideal all year 'round? We need experienced Tooling Engineers, Plastic Mold Designers, Tool & Die Makers, Injection Molders and Compression Molders. Write, wire or call Eldon Manufacturing Company, 1010 East 62nd Street, Los Angeles 1, California.

DEVELOPMENT ENGINEER.
ME or ChE who has demonstrated ingenuity and ability in trouble shooting and/or pioneering new processing techniques or designing new machinery. Must be capable of projecting pilot scale investigations to production size equipment and operations. This job requires technical ability and the determination to produce; plastics experience not required. We are more interested in basic qualifications than related experience. This is an opportunity to join a vital, growing department of a progressive and expanding organization. Please send complete resume, including salary requirements, to
F. J. Bishop
Celanese Corp. of America
290 Ferry St., Newark, New Jersey

CHEMISTS OR CHEMICAL ENGINEERS required to set up and operate plant to polymerize monomer styrene for injection molding powder purposes. Please reply indicating general experience, type of polymerizing process familiar with and salary expected. Reply Box 5013, Modern Plastics.

PRODUCT DEVELOPMENT: Concern in northern New Jersey has an opening for a person with a bachelor degree in either Chemistry or Chemical Engineering to work on the development of products based on fibers, resins or allied fields. One or two years experience desired. Work will involve the development of new and existing products. Reply Box 5000, Modern Plastics.

COME TO TEXAS.
We have permanent opportunities galore for injection molding plant personnel—plant engineer, assistant plant superintendent, foremen, machine operators, maintenance men, set-up men. Inquire about foreman training program. Our employees know about this ad.
Loma Plastics, Inc.
P. O. Box 11277
Fort Worth, Texas

RESIN CHEMIST: Chemist or Chemical Engineer with several years experience in compounding thermoplastic resin dispersions. Salary commensurate with experience. Concern located in central New Jersey. Reply Box 5001, Modern Plastics.

WANTED: Chemist or Chemical Engineer. Young college graduate for development work on phenolic resins. Write: Reichhold Chemicals, Inc., 756 Rockefeller Street, Elizabeth, New Jersey. Call: ELizabeth 3-6600.

FRICTION PRODUCTS ENGINEER or Compounder Thoroughly Familiar with All Phases of Compounding and Manufacturing Friction Materials—Especially Clutch Facings. Reply in Writing Standco Industries, Inc., P. O. Box 93, Houston, Texas, Attention J. M. Dunn.

CHEMICAL ENGINEER.
Outstanding opening with energetic, progressive organization in Northern New Jersey for a man with 2-5 years experience in application research in field of processing, compounding and formulating of polyvinyl chloride, rubber, etc. Experience in calendered plastics, either film or sheeting preferred. Familiarity with pilot plant and manufacturing operations essential. Write with full particulars including salary required.
Reply Box 5027, Modern Plastics

PLASTIC SALESMAN WANTED by Chicago area Custom Injection Molder. We are in the process of expanding and have a newly created position for the right man with proven background of accomplishment in Sales. Opportunity to become Sales Manager with executive capacity. Salary plus commission. Reply Box 5005, Modern Plastics.

CHEMISTS AND CHEMICAL ENGRS.
For product development in plastics field. Outstanding opportunity to join recently formed Product Development Department of the Atlas Powder Company, located in Wilmington, Delaware. 5-10 years experience in polymers and their application uses required. All responses held confidential. Direct all replies, marked personal to,
R. L. Herrman
Atlas Powder Company
Wilmington, Delaware

TECHNICAL SALES/SERVICE: Excellent opportunity for technical graduate interested in sales-service, who has two or more years experience with vinyl application. Opening is in rapidly expanding division of an established Midwest Chemical Manufacturer. Please send resume including salary requirements. Reply Box 5015, Modern Plastics.

VINYL COLOR MATCHER.
Man experienced in color matching and production color control in film and sheeting.
Reply Box 5018, Modern Plastics

GROUP LEADER: Organic chemist with 5-20 years experience in plastics, vinyl stabilizers and related compounds. To head new group in a growing, progressive organization. Pleasant working conditions in a new air-conditioned laboratory. Midwest location. Fringe benefits. Send resume including photo and salary desired. Reply Box 5019, Modern Plastics.

PART TIME SALESMAN.
Salesman handling Electronic Supplies to sell Plastics to the Electronic Industry; Including Casting Resins, Coating Compounds, Foams, Adhesives, Rods and Sheets. Give details on present line and territory.
Reply Box 5006, Modern Plastics

GOOD FUTURE IN CANADA for plastics engineer: One of Canada's largest and fastest growing plastics manufacturers needs a fully qualified Plastics Plant Superintendent age 30-40. Applicants should have University Degree and experience in one or more of the following: compression moulding, injection moulding, extrusions, vacuum forming, low pressure laminating, fabricating and silastics. Good working conditions in new plant situated near Toronto, Ontario, extensive employee benefits and a salary commensurate with ability. Apply by letter outlining qualifications, age and experience, to: Personnel Manager, Smith & Stone Limited, 50 St. Clair Ave. W., Toronto, Ontario.

FLOOR TILE CHEMIST.
Experienced manufacture vinyl tile. Location, Midwest. Liberal insurance and pension plan.
Reply Box 5017, Modern Plastics

PLASTICS CHEMISTS.
Unusual opportunity for men experienced in processing of thermoplastic resins. Background is desired in one or more of the following fields: Injection molding; Extrusion (film, tube, and wire coating); Compression molding; and Laminating. Long-range prospects excellent for experienced men to work in a stable, progressive organization employing a staff of over 2100. Please write today to:
The Personnel Manager
Battelle Memorial Institute
505 King Avenue, Columbus 1, Ohio

ENGINEERS. Research in Audio, Plastics. Cements & Adhesives Salary Arrangements Open. Apply Pratt, Read & Co., Inc., Ivoryton, Conn.

INDUSTRIAL SALES.
We are seeking a chemist or chemical engineer to sell phenolic and urea resins to industrial accounts. Proven sales ability is essential. Knowledge of resins and plastics would be helpful, but not necessary. Excellent opportunity for a top quality man. Eastern territory, salary, bonus, all expenses. Our company is a large prime manufacturer of plastic materials with nation wide coverage.
Reply Box 5025, Modern Plastics

PRODUCTION MGR. FOR PLASTICS: Wanted. A Man with Heavy Compression Molding Experience to Assume Responsibility for Production in Progressive Plastics Plant. Send Resume and Salary Requirement to: David Rome. Olympic Plastics Company, 3471 So. LaCienega Blvd., Los Angeles 16, California.

VINYL CHEMIST.
Manufacturer calendered film and vinyl sheeting requires experienced chemical engineer or chemist. All replies confidential.
Reply Box 5016, Modern Plastics.

INJECTION MOLDING PLANT Superintendent Wanted. Take full charge of men, molding and maintenance of seven Reed-Prentice Machines. Excellent opportunity for a capable man with fast growing company molding our own items plus some custom molding. Reply giving age, experience and salary. Baby World Co. Inc., 36-31 33 St., Long Island City, New York.

PLASTICS SALES ENGINEER.
Large established and well respected Chicago Injection Molding, Finishing and Extrusion Company seeks experienced man with Industrial and packaging experience. Salary plus commission. Will be given active territorial accounts. All replies strictly confidential.
Superior Plastics, Inc.
426 No. Oakley Blvd.
Chicago 12, Illinois

PLASTICS TECHNOLOGIST: Opportunity in San Francisco Bay Area for a chemist or chemical engineer with 3 to 6 years experience in the compounding and application of thermosetting resins and other polymers. Research involves the evaluation of new materials and the development of their uses. Please write giving personal and work history to: Shell Development Company, Emeryville 8, California.

PLASTIC EXTRUSION CHEMIST: Graduate chemist or chemical engineer required with formulation and practical industrial experience on flexible and rigid vinyl extrusions as well as general plastic knowhow. Replies held confidential. Excellent opportunity. Reply Box 5007, Modern Plastics.

HELP WANTED.
Maintenance engineer for plastic calenders, mills, banbury.
Must be experienced.
Reply Box 5031, Modern Plastics

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Situations wanted

TECHNICAL SALES SERVICE ENGR. or Chief Engineer: Twelve years Rubber and Plastics, trouble shooting, installation, intimate technical knowledge of Internal Mixers, Mills, Calenders, Extruders, Presses, Tire Plant, Plastics Extrusion, Design of special equipment, English, resident of Canada, present territory Canada and States. Good connections Europe and North America, anywhere in World. Reply Box 5023, Modern Plastics.

YOUNG EXECUTIVE with experience in company producing injection and compression molded products for the packaging industry seeks position in forward-looking organization. Will welcome investment opportunity in proper company. Graduate of eastern university, married, Service commitment fulfilled, Age 26. Reply Box 5020, Modern Plastics.

PLASTICS ENGINEER: B.Ch.E., M.S. Seeking position as assistant plant manager, or manager if small plant. Four years diversified experience in responsible positions with major chemical and plastics company. Design and development of extruders, operation of thermoplastics, organics, plants. Styrene, vinyls, polyesters. Plant supervisor, process development, report writing, chemical economics, cost estimates. Sound knowledge of plastics industry. Honor societies, patents, papers. Reply Box 5029, Modern Plastics.

EXECUTIVE CHEMIST: B.S., 1948. Eight years experience in the formulation and application of industrial organic coatings; PVC resins, primarily organosols, plastisols, laticies and related chemicals. Presently Assistant Technical Service Director. Desire responsible sales or technical service position with progressive company in the Ohio area. Reply Box 5024, Modern Plastics.

Sales agents wanted

MANUFACTURER of rigid plastic sheets seeks manufacturer's representative for new line of optically clear, Cast Acrylic Sheets. Position requires calls on distributors, fabricators and end users. Enterprising salesman can attain high earnings with product much in demand. Commission basis Reply Box 5008, Modern Plastics.

SALES REPRESENTATIVES.
Wanted in St. Louis and Michigan and/or Detroit territories to sell custom molding or commission basis for top grade molder specializing in thermosetting and nylon electro-mechanical parts. Should be familiar with all phases of selling involving tooling. Reply stating age, experience and present lines.
Whitso, Inc.
9330 Byron St.
Schiller Park, Ill.

DISTRIBUTORS or Sales Representatives wanted by East Coast Manufacturer of Electronic Heat Sealing machinery. Products advertised nationally. Excellent potential. Send full data with background and experience, territory covered, and present lines handled. Also seeking salesmen to work out of New York office in Metropolitan area. Reply Box 5009, Modern Plastics.

MANUFACTURER'S REPS. WANTED: in Illinois, Iowa, Michigan, Minnesota, Missouri and Wisconsin by midwest fabricator and finisher with complete facilities for processing sheet, rod and tube, including high volume assembly. Commission basis. Reply stating territory now covered, experience and other lines being handled. Reply Box 5002, Modern Plastics.

MANUFACTURERS REPRESENTATIVE wanted by Chicago area Custom Injection Molder. Modern plant with tool room. Molding capacity up to 16 oz. with facilities for finishing molded parts. Commission basis. Most territories open. Reply Box 5004, Modern Plastics.

SALES AGENTS WANTED: Midwest, injection and expanded styrene molder wants representative to cover refrigerator manufacturers and other industrial accounts in Columbus, Dayton, Cincinnati, Indianapolis, Louisville area. Commission basis. Orders already on hand would be turned over to representative on half commission basis and new would pay full commission. Excellent opportunity for a go getter with drive and imagination. Reply Box 5035, Modern Plastics.

Miscellaneous

COMPRESSION MOLDED SOURCE needed: Long established reputable Ohio manufacturers' representation organization needs compression molding concern seeking orders for compression molded parts weighing more than 6 oz. Interested in limited or broad territory arrangement on straight commission basis only. Plastic Product Sales, P. O. Box 494, Dayton 1, Ohio.

SKEIST LABORATORIES.
We Can Help You Solve Your Plastics Problems. Save time and money through custom research designed to fit your needs. Specialists in product, process and market research on plastics, plasticizers, polymers, adhesives, coatings. Comprehensive reports are available on the economics and technology of Plastics and Plasticizers.
Irving Skeist, Ph D., director
89 Lincoln Park, Newark 5, N. J.
Market 3-5002

All classified advertisements payable in advance of publication

Closing date: 28th of the second preceding month, e.g., Jan. 28th for Mar. Issue

Up to 60 words $10.00	Up to 120 words $20.00	Up to 180 words $30.00
Up to 60 words (boxed) $20.00	Up to 120 words (boxed) $40.00	Up to 180 words (boxed) $60.00

For further information address Classified Advertising Department, Modern Plastics, 575 Madison Avenue, N. Y. 22, N. Y.

ENGINEERING ASSISTANCE

Are you thinking of making a plastics product?

We can help you.

Out of our 25 years of "A-to-Z" experience in the plastics field, we can help you with all the difficult and often-bewildering problems involved in developing a plastics product. Step by step, we'll work with you to solve design problems, develop a prototype model, decide on the best plastic, and then give you our unbiased assistance in selecting a molder or fabricator with the experience and equipment for your specific requirements.

You'll have available to you all types of molding, forming, and fabricating equipment for plastics development work. And you will be working with Mr. Fred Stanley, whose 25 years' experience in the plastics industry consists of 12 years in plastics engineering, sales, and production work, and 13 years as Engineering Editor of Modern Plastics magazine.

Write or phone for additional details. It may be just the engineering assistance you've needed.

FRED B. STANLEY

101 Sequams Lane West
Babylon, L. I., New York
MOhawk 9-1097

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NO REJECTS HERE!

And you'll get no rejects when you lubricate your molds with Metasap® Zinc or Calcium Stearates. Your finished products pop out of the mold quickly, easily, smoothly.

You can verify this with most any experienced molder.

You can add these Stearates in either of two ways. Incorporate them in the molding compound...or simply dust them onto the mold surface.

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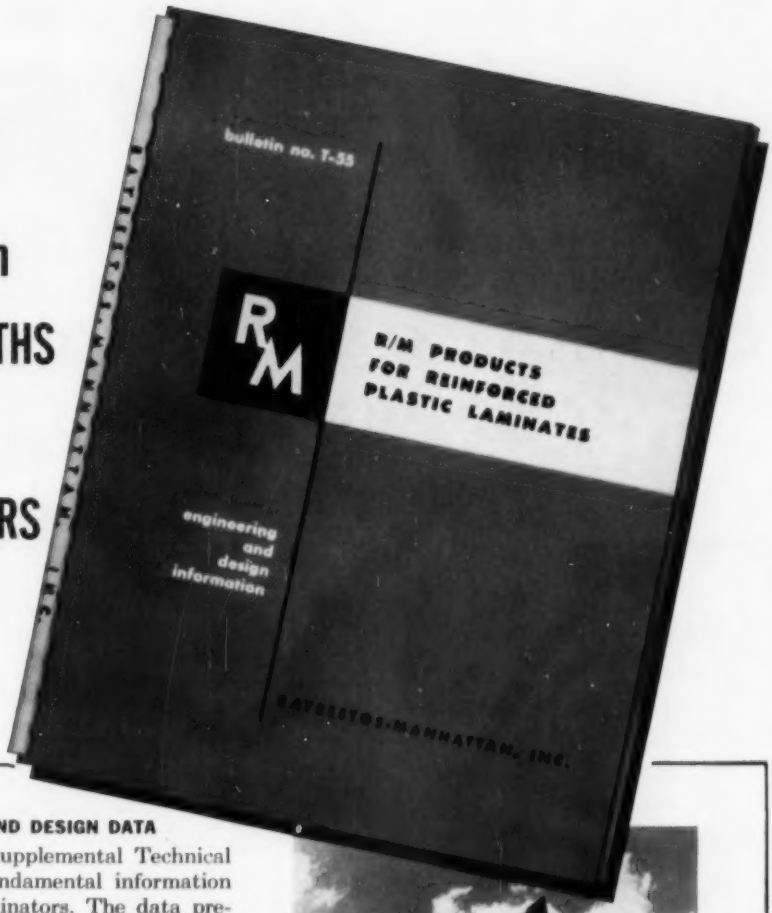

CONTAINS TECHNICAL AND DESIGN DATA

R/M Bulletin No. T-55 and supplemental Technical Data Sheets present useful fundamental information for high and low pressure laminators. The data presented should suggest new uses and markets to you for scientifically engineered plastic products.

EXAMPLE

It describes, for example, R/M No. 9526 Pyrotex Felt, recommended for such end-applications as rocket and guided missile control surfaces, fuel containers, combustion and exhaust chambers. You learn that this felt is 100% long, staple, non-ferrous asbestos fiber, and has exceptional multi-directional developed properties: tensile strength, 50-55,000 psi; flexural strength, 50-60,000 psi; compressive strength, 25-30,000 psi; modulus of elasticity, 4-5 x 10^6 psi; developed properties, relatively isotropic.

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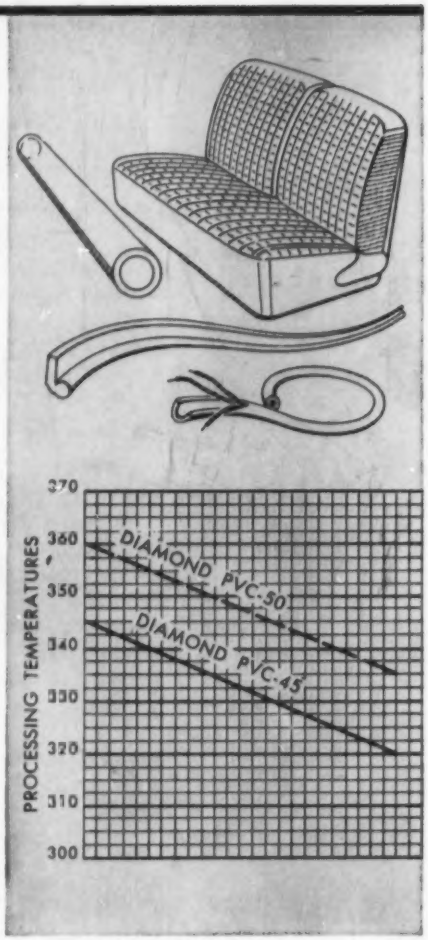

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